POWER

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Improve the Industrial Plant

IT IS not so very long ago that we were discussing the possibility of generating a horsepower-hour with a pound of coal.

Today several of the large electric stations are generating, not a horsepower-hour, but a kilowatt-hour on around 14,000 B.t.u.

These plants embody the latest and best in design, apparatus and operation.

There are some industrial plants that have kept up with modern development and are paying good returns upon the money invested in them.

They have also ceased to be accomplices in unwarranted and unnecessary waste of our principal unrenewable natural resource.

But the majority of them continue to be extravagantly inefficient, devoid of intelligent design, running with antiquated apparatus, without records of their performance, without adequate measuring, indicating and recording instruments to guide their operators and enable informing records to be made, without those mechanical appliances that relieve the personnel of grilling, arduous muscular labor and make the jobs attractive to men of brains.

Independent observers have found the average boiler efficiencies of many industrial plants to be about 56 per cent. Inexpensive overhauling and intelligent operation would put it up to over 70. With intelligent adaptation of available apparatus 80 per cent is easily available even in moderate-sized plants.

The electric utilities use something like 8 per cent of the coal that is mined in the United States; the industries, hotels, office buildings, etc., about 35 per cent.

We mine between 500,000,000 and 600,000,000 tons annually.

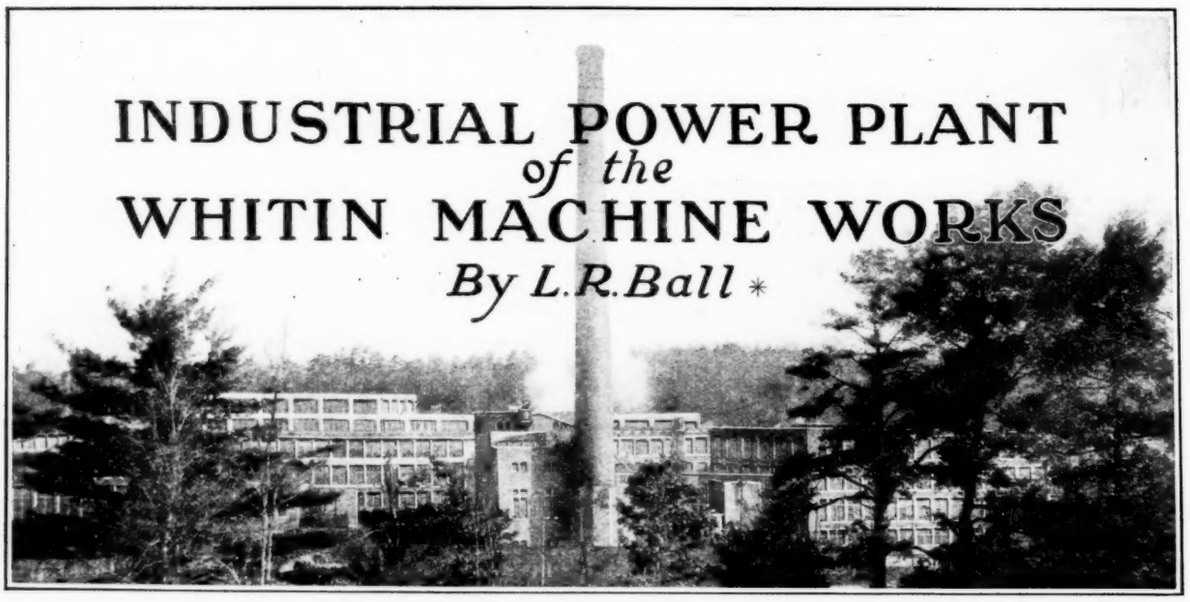
If the industries use one-third of this and could save one-fifth of what they use, it would amount to 30 or 40 million tons a year.

How much of this are you using needlessly?

F. R. Low

INDUSTRIAL POWER PLANT of the WHITIN MACHINE WORKS

By L. R. Ball *



Forty acres of floor space are served with heat, light, power and process steam

LARGE textile machinery concern rebuilds power plant and changes over the frequency from 40 to 60 cycles without mishap and with machine shops running at full capacity. Reciprocating engines have been replaced by a 2,000-kw. bleeder turbine which supplies both power and low-pressure heating requirements. Bituminous coal is supplemented by wood refuse. Outside power is available. Welded pipe lines are a feature in the new power plant. Provision is made for expansion.

THE Whitin Machine Works, in the village of Whitinsville, Massachusetts, and one of the oldest and largest concerns devoted entirely to the manufacture of textile machinery, has, ever since its beginning nearly one hundred years ago, maintained its own power plant for supplying the necessary power and heating. As time has gone on, the works have grown steadily, with the result that larger and more economical power equipment has been installed to take care of increased demands.

By 1908 two main generating units—a cross-compound condensing Corliss engine directly connected to a 500-kw. 600-volt 40-cycle generator, and a single-cylinder condensing or non-condensing Corliss engine, belted to a 300-kw. 600-volt 40-cycle generator—took care of the industrial power and lighting load. Direct current at 550 volts was supplied to the local street railway by a 300-kw. rotary converter.

Steam for these units was taken at 160 lb. pressure from ten vertical fire-tube boilers (two 75-in. and eight 72-in.). These also supplied steam to two air compressors, the auxiliaries, and the heating system. The compressors and the single-cylinder engine furnished low-pressure steam for drying lumber and some heating.

*Power cost engineer, Whitin Machine Works.

During 1908 the load increased to such a point that eight more 75-in. vertical fire-tube boilers were installed together with a four-valve cross-compound condensing engine directly connected to a 1,000-kw. 600-volt 40-cycle generator. The heating requirements for the most part were then furnished by the eight 72-in. boilers which were thereafter used exclusively for the shop hot-water heating system.

With these additions it was thought that the power requirements would be satisfied for many years, but by 1920 the works had grown to such an extent that the power-plant equipment was again taxed to capacity. As an extensive building program was under way, it was evident to the officials that a complete revamping of the power plant was necessary to cope with both the present and the future demands for power, process steam and compressed air.

The question of discontinuing its own power plant and the purchase of all electrical energy from outside sources was considered; but, after studying all factors, particularly the heating requirements, it was decided to rebuild the power plant and install a 2,000-kw. bleeder turbine, which would supply the necessary power and low-pressure process steam. It was also deemed advisable to tie in with the lines of the New England Power Co. so as to facilitate changing over, and then to use outside power as a stand-by, and also for the night load, except during the heating months when the turbine would be run extracting both day and night. In this way the advantages of purchased power have been obtained, together with the economy of producing power as a byproduct from the steam required for heating.

As the frequency was to be changed from 40 to 60 cycles, a great deal of expense was involved both in the power plant and all over the works; for the generating units, motor-driven auxiliaries, rotary converters, etc., had to be changed, together with several hundred motors serving about 40 acres of floor space. This was done after outside power was brought in. To avoid interference with machine-shop operations, the old 40-cycle motors were replaced by 60-cycle motors

on Saturday afternoons and Sundays, and in this way the power load was finally shifted from the 40-cycle generating units to the New England Power buses.

While this was going on, the two Corliss engines were broken up and their foundations blasted out, so as to make room for modern equipment. As a matter of interest, the 1,000-kw. engine was still carrying its load while the foundations adjacent to it were being blown out, and no accidents occurred. As soon as the new 2,000-kw. turbine was installed, it was piped up temporarily to the ten 75-in. vertical boilers, which carried the load at reduced pressure for a period of 11 months before the turbine took steam at 200-lb. pressure, from the new boiler plant. Then the 1,000-kw. engine was removed and its foundation blasted out.

The new power plant contains the latest type of equipment. Although the two boilers and turbine installed at present are only able to take care of present demands, provision has been made in the whole layout for future expansion, as space is available for three more boilers and all the main piping and connections are installed for two more bleeder turbines. The plant is well equipped with instruments which enable the operators to know what is going on at all times and in this way the most economical operation is obtained. The building is of steel, concrete and brick. The boilers, stokers and ash hoppers, as well as various machines, are supported on steelwork independent of the building steel.

As the plant is situated one and one-half miles away from the railroad sidings, the coal cars are hauled over the local electric street railroad. On reaching the yard, the coal, by means of a locomotive grab-bucket hoist, is either placed in storage where space is available for 15,000 tons, or unloaded directly into a series of side-dump cars of 2,500-lb. capacity.

These are hauled by a small electric motor to the power station. Here the coal is discharged into a receiving hopper, from which it is fed at a uniform rate into a toggle spring-release motor-driven coal crusher. From the crusher the coal is discharged to a continuous bucket elevator, which, in turn, discharges onto a 16-in. belt conveyor. A self-propelling tripper distributes the coal to the parabolic steel boiler-room bunker, which has a capacity of 250 tons. The coal-handling equipment is fully inclosed and has a normal capacity of 40 tons an hour. All the motors have individual control and interlocking master control, so that the whole system can be stopped from above to avoid jamming with coal in case of trouble.

From the bunker the coal is delivered to automatic scales, which weigh and then discharge the coal down the chutes into the stoker hoppers.

The ashes are handled at little expense. Each boiler is equipped with a modern type of ash hopper, from which the ashes are discharged into the industrial side-dump cars through steam-operated ash grates. The ashes are then used for general filling in around the yard.

Steam Generating Equipment

The new plant is provided with two (ultimate capacity of five) 6,240-sq.ft. horizontal water-tube boilers, designed for 225-lb. pressure. They are equipped with soot blowers and with superheaters located above the first and second passes. Under normal conditions the boilers are worked at 200-lb. pressure. At 100 per cent rating the steam is superheated 100 deg.

After making three passes over the tubes, the products of combustion discharge into the main breeching, which runs over the top of the boilers and communicates with the 250-ft. brick stack. No economizers are used. Each boiler is equipped with a 7-retort underfeed stoker driven by a 5x5-in. vertical engine, manually controlled.

The boiler settings are provided with air-cooled perforated carborundum blocks placed in the front, side and bridge walls to prevent slagging and clinkering.

Air for combustion is supplied under pressures varying from 2 to 5 in., by a turbo-blower in the basement. This blower, which is controlled by the steam pressure, has a capacity of 30,000 cu.ft. per minute at 6-in. static pressure, and is designed to furnish air to the stokers when operating the boilers at 200 per cent rating, although they are often operated at 250 per cent rating. The draft over the fires is maintained at about

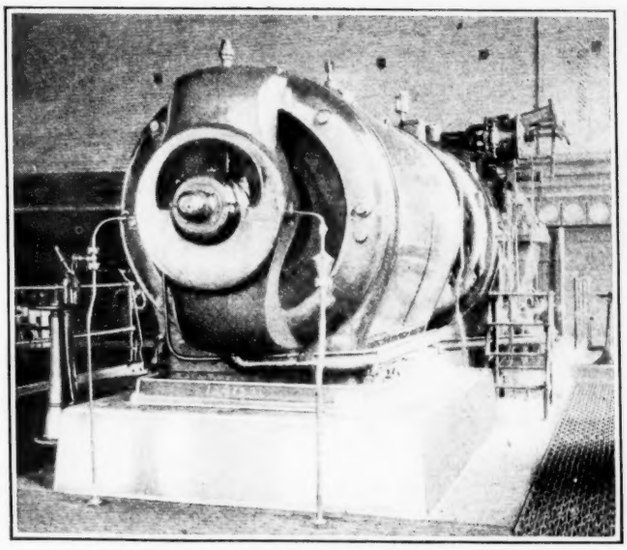


Fig. 1—This 2,000-kw. condensing turbine supplies bled steam at 7 lb. gage for process and heating

0.05 in. by manually operating the back dampers through an arrangement of levers extending to the boiler fronts, at which point the gages, showing the drafts over the fire, under the fire and in the last pass, can be observed. Each boiler is served by a steam-flow air-flow meter which also records the temperature of the flue gases.

Burning Wood Refuse

Shavings and sawdust from the wood-working departments are conveyed by means of blowers through 14-in. pipe lines 500 ft. long and discharge into a cyclone on the station roof. From this they are discharged by gravity to the boiler furnaces. Steam jets have been installed to distribute the material over the fires. Most of this fuel is burned in suspension. No trouble is experienced in obtaining good combustion. The boiler meters are set for 136 per cent total air and are checked up at regular intervals by a standard Orsat.

Practically all condensate and drips are returned, either directly or indirectly by means of a receiving tank under float control, to the open heater in the turbine room. What makeup water is required is taken from the trench that supplies water for condensing and cooling purposes. It is forced through the primary

heater, which is between the air-compressor exhaust and the barometric condenser.

The makeup is controlled by a discharge-pressure regulator on the makeup pump, working in conjunction with the float-controlled valve at the open heater. No water softener is necessary, as the water is very good for boiler purposes, having a total solids content of only 2.47 grains per U. S. gallon. Another source of makeup water is available through the 110-lb. town supply which is also controlled by the float valve at the open heater previously mentioned.

A feed-water temperature of about 212 deg. is maintained by automatically regulating the flow of steam from the 20-in. low-pressure header to the heater. The feed water flows under a gravity head of 14 ft. to the turbine-driven boiler-feed pump in the basement, which delivers the water through a venturi meter, direct to the boilers. Only one feed pump is installed at present; two large-sized injectors are provided for emergency use.

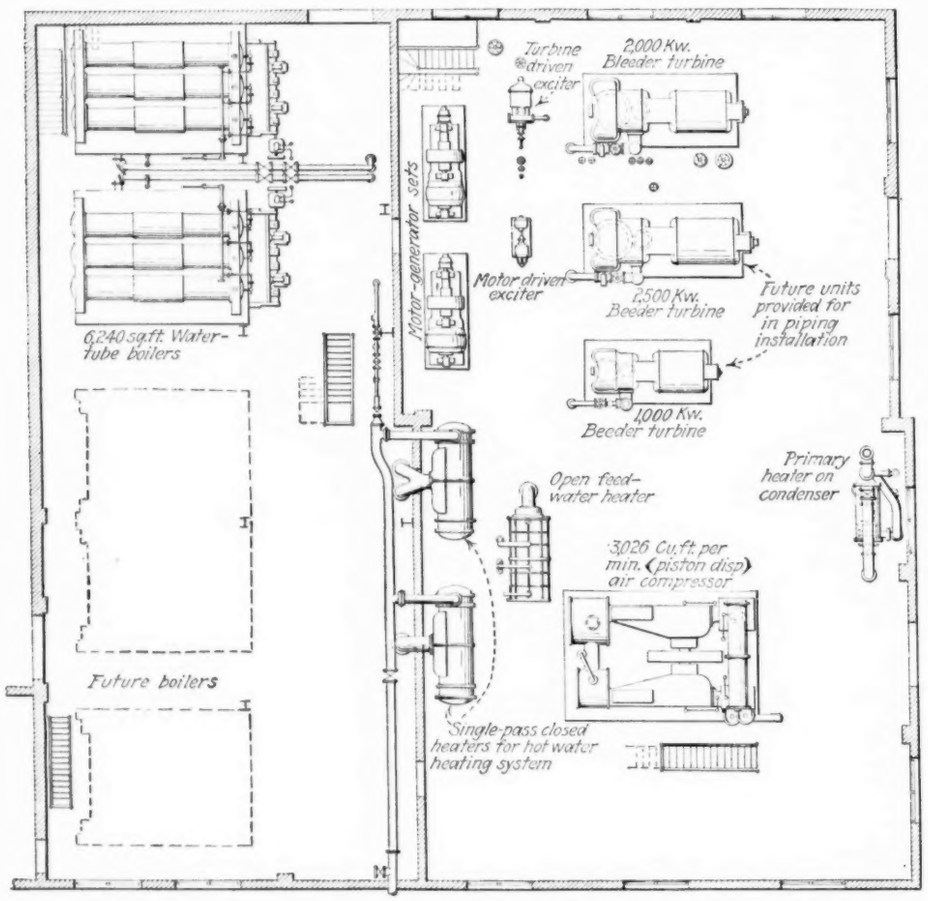

Turbine driven exciter
2,000 Kw. Bleeder turbine
Motor-generator sets
Motor driven exciter
2,500 Kw. Bleeder turbine
Future units provided for in piping installation
1,000 Kw. Bleeder turbine
6,240 sq.ft. Water-tube boilers
Primary heater on condenser
Open feed-water heater
3,026 Cu.ft. per min. (piston disp.) air compressor
Future boilers
Single-pass closed heaters for hot water heating system

Fig. 2—Layout of plant

The two boilers and turbine now installed could not carry more than present demands, but provision has been made in the whole layout for future expansion. Space is available for three more boilers and all the main piping and connections are installed for two more bleeder turbines. This sketch indicates the turbine-room floor level. No attempt has been made to depict the extensive piping system, most of which is in the turbine-room basement.

Steam Piping

The piping layout in this plant is exceptional. Extensive use has been made of oxyacetylene welding, both in the fabrication of the main steam headers and in the general piping. By means of fusion welding, gaskets, which are a source of trouble, are reduced to a minimum. Few leaks have started since the plant was completed. Our own welding department is available to take care of any leaks that occur.

By means of welding, piping is simplified considerably, in that a great deal of work can be done in the field, and all ordinary fittings can be eliminated. Expansion joints and bends take care of expansion, and all piping is braced and suspended from I-beams or brackets.

Each boiler is connected to the 12-in. high-pressure steam header by a separate 8-in. line, each being equipped with a non-return valve and a flow meter. All the piping is below the turbine-room floor. The 12-in. high-pressure header has been valved for sectionalizing if necessary, and steam for all units, together with the high-pressure process lines running east and west of the power plant, is taken directly from it.

The exhaust from all turbine-driven units, together with steam bled from the main generating unit, discharges into the 20-in. low-pressure steam header, where the pressure is maintained at about 4-lb. gage. High-pressure steam can also be bled through a reducing valve into the 20-in. low-pressure header if required. This low-pressure header supplies the open heater and the two closed hot-water heaters for the shop hot-water heating system. The exhaust from the stoker engines, etc., which carries oil, goes into a separate 6-in. exhaust line, into which low-pressure steam from the 20-in. header can be bled for drying lumber. The condensate from this source does not return to the boilers.

Turbine-Room Equipment

The 2,000-kw. (at 80 per cent power factor) condensing turbine and generator unit, with three-phase 60-cycle 600-volt generator and automatic extraction control between limits of 4-lb. gage and 11-lb. gage, is the only main generating unit installed. Space is available, however, and all main connections provided for two similar units of 2,500-kw. and 1,000-kw. capacity. In Table I are figures showing the performance

of the 2,000-kw. generating unit, based on 200 lb. gage pressure and 100 deg. superheat at the turbine throttle, 7½ lb. gage pressure at the extraction opening of the

TABLE I—PERFORMANCE OF 2,000-KW. GENERATING UNIT

Load, Kw.	Steam Rate, Lb. per Kw.-Hr. (No Steam Bled)	Lb. Steam Extracted per Hour at 7½ Lb. Gage Back Pressure	Total Flow Through Throttle Lb. per Hr.
2,000	....	36,400 (maximum)	50,800
1,500	....	47,700 (maximum)	50,350
1,000	....	33,600 (maximum)	36,250
2,000	....	25,000	44,500
1,500	....	25,000	38,000
1,000	....	25,000	31,800
2,000	....	15,000	38,900
1,500	....	15,000	32,600
1,000	....	15,000	26,600
2,000	....	5,000	33,200
1,500	....	5,000	27,000
1,000	....	5,000	21,200
2,000	15.1	.....	.....
1,500	15.6	.....	.....
1,000	17.1	.....	.....

turbine, and 2 in. of mercury absolute back pressure in the exhaust chamber of the turbine.

The turbine is placed on a structural-steel support with its condenser directly beneath, connected through a copper expansion joint. Water for condensing purposes flows through the surface condenser under a gravity head and discharges into the discharge tunnel below the basement floor.

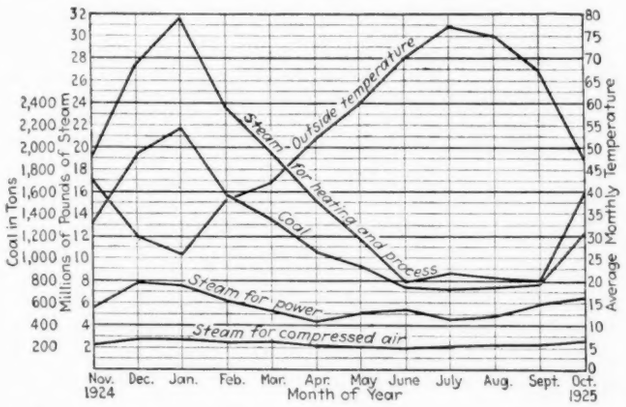


Fig. 3—Yearly load curves showing distribution of steam output of boilers and influence of outside temperature on coal consumption

A new high-duty steam-driven duplex air compressor of 3,026-cu.ft. piston displacement per minute has been installed in the turbine room. This is likewise supported on steelwork. Besides this machine, which is large enough for future requirements, two smaller ones, of 1,600 and 750-cu.ft. piston displacement per minute, were reclaimed from the old power plant.

Two exciters, one a turbine-driven unit used as a

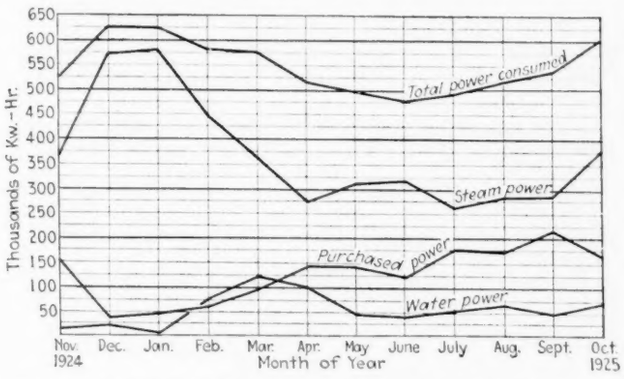


Fig. 4—Yearly load curves showing amount of power obtained from various sources

stand-by, and the other a motor-driven unit, furnish excitation for the main generator fields.

Two 500-kw. synchronous-motor generator sets furnish direct current at 550 volts for the local street railway, while two smaller motor-generator sets furnish direct current at 240 volts for the hoists and magnetic chucks around the works.

TABLE II—COMPARISON OF OPERATING DATA FROM OLD AND NEW POWER PLANTS OF THE WHITIN MACHINE WORKS

	Old Plant (Yr. Ending 12-31-20) Amount	Per Cent of Total	New Plant (Yr. Ending 10-31-25) Amount	Per Cent of Total
Total coal as fired, lb.	38,427,600	100	29,046,700	100
Total water evaporated, lb.	324,972,000*	...	291,596,000	...
Evaporation per lb. of coal, lb.	9.30	...	10.04	
Distribution of coal as fired:				
Coal for power, lb.	15,985,700	41	6,846,800	23
Coal for compressed air, lb.	3,765,000	10	2,783,000	10
Coal for heating and process, lb.	18,676,900	49	19,416,900	67
Kw.-hr. generated by steam power.	4,534,500	85	4,402,010	67
Kw.-hr. generated by water power.	817,200	15	641,980	10
Total kw.-hr. generated	5,351,700	100	5,043,990	77
Kw.-hr. purchased	None	...	1,499,800	23
Kw.-hr. consumed	5,351,700	100	6,543,790	100
Coal per kw.-hr., lb.	3.52	...	1.55	...
Total floor space of works, sq.ft.	1,257,441	...	1,480,820	...
Total volume of space in works heated, cu.ft.	18,924,763	...	21,802,622	...

* Pounds of water evaporated by the ten 75-in. vertical fire-tube boilers which consumed 34,954,500 lb. of coal during the year 1920.

The open feed-water heater is also located on the

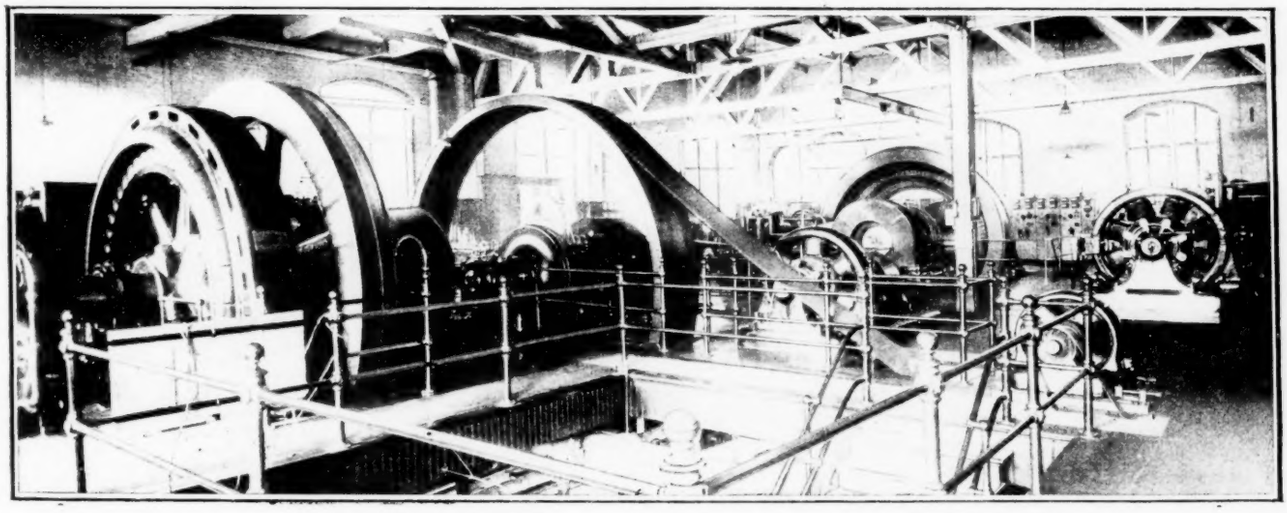


Fig. 5—Engine room as it appeared before revamping was started in 1920

turbine-room floor, together with the two closed heaters used on the forced hot-water heating system.

Steam Power Supplemented by Water Power

The Whitin Machine Works owns two hydro-electric stations which run in conjunction with the steam-power plant. These stations have a combined rating of 560 kw., but no great dependence can be placed on this source of power since the water supply is limited, and at times no water power is available.

The plant was designed and the piping installed by the Grinnell Co., of Providence, R. I., who co-operated with the engineers of the Whitin Machine Works. All foundation and general construction work was carried through by our own building departments, with the exception of the structural steelwork, which was furnished by the Eastern Bridge & Structural Co., of Worcester, Mass.

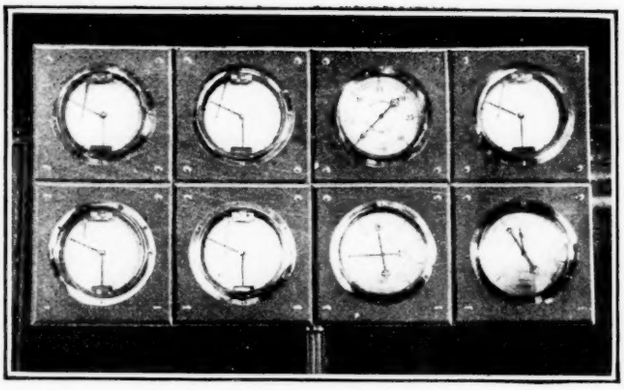


Fig. 6 — Heating-system control board measures hot-water pressures and temperatures, outside and inside air temperatures, etc.

PRINCIPAL EQUIPMENT OF POWER PLANT OF WHITIN MACHINE WORKS

GENERAL

Capacity, present, kw	2,000
Ultimate capacity, kw	5,000
Designing and erecting engineers	Grinnell Co., Providence, R.I.

BOILERS AND SUPERHEATERS

Manufacturer	Edge Moor Iron Co
Number of boilers	2
Type	Horizontal water-tube 3-drum, vertical baffled, 3 passes
Water heating surface per boiler, sq.ft	6,242
Grate area, (proj.) per boiler, sq.ft	98
Working pressure, lb. gage	225 (present operating 210 lb.)
Superheaters (Foster)	Power Specialty Co.
Type	Single loop convection
Location of superheater	Above first and second passes
Superheat at 100 per cent rating, deg. F	100

STOKERS

Manufacturer	Riley Stoker Corp.
Type	Seven-retort Riley underfeed
Stoker drive, 2 vertical engines	5x5 in. vs. 7 Sturtevant engines

FORCED-DRAFT EQUIPMENT

Manufacturer	B. F. Sturtevant Co.
Number	1
Type and size	No. 80 Turbovane, design 4
Capacity, cu.ft. per min	30,000 at 6 in. static pressure
R.p.m.	1,745
Drive	Direct connected to 48-hp. type C-10 Sturtevant turbine
Draft control	Ruggles Klingemann pressure regulator

CHIMNEY

Erected by	Alphons Custodis Chimney Construction Corp.
Type	Radial brick.
Height, ft	Above base—250, above grates 232
Inside diameter at top, ft	11.0

FEED-WATER HEATERS

Manufacturer	Cochrane Corporation
Number and type	1 open, horizontal, cylindrical
Capacity, lb. per hr	105,000

BOILER-FEED PUMP

Manufacturer	Alberger Pump & Condenser Co
Number and type	1 3-in. Alberger 3-stage type N, centrifugal, 225 lb. discharge
Capacity	250 gal. per min.
Drive	60-hp. Alberger-Curtis turbine

COAL AND ASH HANDLING

Manufacturer	Stephens-Adamson Mfg. Co.
Crusher	S.-A. double roll, 24x24 in. motor driven, 40 tons per hr.
Continuous bucket elevator	72 ft. centers, motor driven, speed 100 ft. per min., capacity 40 tons per hr.
Belt conveyor	One 16-in. 101 ft. centers, speed 200 ft. per min. equipped with self-propelling tripper, capacity 40 tons per hr.
Overhead bunker, capacity and type	250 tons, parabolic steel
Coal scales, two	Richardson Scale Co.
Locomotive crane, yard storage and reclaiming	Meyers
Yard, coal storage	15,000 tons
Ash gates, steam operated	Baker, Dunbar Co.

TURBO-GENERATOR

Manufacturer	General Electric Co.
Type	Curtis, 4 stages, equipped with automatic extraction control
Capacity	2,000 kw. at 80 per cent power factor
Speed of unit, r.p.m.	3,600
Throttle pressure and superheat	200 lb. gage and 100 deg. F.
Type of generator	ATB., 3-phase, 60-cycle, 600-volt
Ventilating air	9,000 cu.ft. per min.

Guaranteed water rate:
Steam conditions, 200 lb. gage pressure, 100 deg. F. superheat, 2 in. abs. back pressure, no steam bled

Load, Kw.	Lb. of Steam per Kw.-Hr.
2,000	15.1
1,500	15.6
1,000	17.1

CONDENSERS AND AUXILIARIES

Number and type	1, 14-in. barometric
Manufacturer	Worthington Pump & Machinery Corp., Knowles Works
Number and type	1, Spiroflo surface, 2-pass, horizontal
Manufacturer	Alberger Pump & Condenser Co.
Tube surface, sq.ft	4,140
Sq.ft. of tube surface per kw. generator rating	2.07
Air occluder	Alberger Pump & Condenser Co.
Condensation pump	Alberger, Redondo type, centrifugal direct-connected to turbine
Exciters, two	General Electric Co.
Type	One, 25-kw., 125-volt, motor-driven One, 35-kw., 125-volt, turbine-driven

AIR COMPRESSORS

Manufacturer	Ingersoll-Rand Co.
Number	Three
Capacity, pist. disp., cu.ft. per min	3,026, 1,600, 750

MISCELLANEOUS MECHANICAL EQUIPMENT

Cold-water service pump, one	Ingersoll-Rand Co.
Hot-water service pumps, two	Alberger Pump & Cond. Co.
Drip pump, two	Alberger Pump & Cond. Co.
Makeup water pump	Warren Steam Pump Co.
Hot-water heaters, two	Alberger Pump & Cond. Co.
Primary heater, one	National Pipe Bending Co.
Barometric condenser pump, one	Worthington Pump & Machinery Corp., Knowles Works
Structural steel fabricated by	Eastern Bridge & Structural Co.
Traveling crane, 20 ton	Maris Bros.
Fire pumps, two	Worthington Pump & Mach. Corp.
Valves, steel	Jenkins Bros.
Piping, steel	Grinnell Co.
Soot blowers	Diamond Power Spec. Corp.
Safety valves	Ashton Valve Co.

STATION INSTRUMENTS

Venturi meter	Builders Iron Foundry
Steam-air flow meters	Bailey Meter Co.
Steam-flow meters	General Electric Co.
Draft Gages	Hayes
Orsats	Bailey Meter Co. & Hayes
Indicating thermometers	Taylor Instrument Co.
Indicating pressure gages	Foxboro Co.
Recording gages, pressure and temp	Foxboro Co.

ELECTRICAL EQUIPMENT

Transformers, three, 1,000 kva., 13,800 575 volt	Pittsburgh Transformer Co.
Other switching and electrical equipment	Westinghouse Elec. & Mfg. Co. General Electric Co.

Draft of Chimney

By J. G. MINGLE

THIS is the first of a series of three articles on the general subject of chimney design. This article discusses the fundamental draft equation

DRAFT, in general, is a difference in pressure which is available for producing a flow of gases. In steam-plant operation draft may be produced by artificial, or mechanical, means, or by natural, or thermal, means.

Artificial draft is ordinarily produced by means of a fan, or blower, and natural draft by means of a chimney and heat. Draft may be either above or below atmospheric pressure. A pressure above atmospheric pressure, however, is usually termed a plenum, while a pressure below atmospheric pressure is called a draft.

Natural draft is produced thermally and is the result of a difference in temperature. It is a static pressure, and no element of motion is inferred when reference is made to it. Its production, however, causes, or attempts to cause, a circulation. The gases inside the chimney are compelled to flow owing to the unbalanced pressure.

Natural draft is the difference in pressure, or the difference in head, produced by the difference in weight between the hot air or gases inside the chimney and an equal column of outside air. When the air or gases inside the chimney are at the same temperature as the outside air, or atmosphere, there will be no difference in pressure and no tendency for the gases to flow. When the gases inside the chimney are relatively hot, their weight per unit volume will be less and they will tend to rise just as a balloon that has been filled with hot air or gases rises. Thus a difference in pressure will be produced, resulting in a tendency for the gases to flow upward. When a circulation has been started, the action becomes continuous and will be prolonged as long as the gases continue to be heated and there is a clear passage.

Definition of Natural Draft

Owing to the many varied definitions that have been assigned to the term natural draft, considerable confusion seems to exist as to its true nature and meaning. The following illustration explains the term explicitly: Let it be assumed that a chimney that has been filled with hot gases is suspended in mid-air and that a diaphragm of a thin, impervious material is securely attacned to the bottom of the shaft. There will of course be a pressure on both sides of the diaphragm, that on the outside being due to the atmosphere which tends to force the diaphragm upward and that on the inside being due to the pressure of the hot gases which tends to force the diaphragm downward. Since the density of the hot gases is considerably less than that of the outside air, the downward pressure due to the gases is less than the upward pressure due to the atmosphere. The difference in pressure is called the draft.

For convenience natural draft is measured in terms of inches of water. One inch difference in the level of the two water columns of a U-tube corresponds closely to a difference in pressure of 5.2 lb. per sq.ft.

The intensity of the *theoretical* draft of a chimney is given by the equation:

$$D_t = 6.436 H P_o \left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right) \qquad (1)$$

in which

D_t = Theoretical draft, in. of water;
H = Height of chimney above grate bars, ft.;
P_o = Atmospheric pressure, lb. per sq.in., absolute;
W_o = Density of the outside atmosphere, at 32 deg. F. and sea-level atmospheric pressure, lb. per cu.ft.;
T_o = Absolute temperature of the outside air, deg. F.;
W_c = Density of the chimney gases at 32 deg. F. and sea-level atmospheric pressure, lb. per cu.ft.;
T_c = Absolute temperature of the chimney gases, deg. F.

Or

$$D_t = 3.16 H B_o \left(\frac{W_o}{T_o} - \frac{W_c}{T_c}\right) \qquad (2)$$

in which B_o = observed atmospheric pressure, in. of mercury.

The theoretical draft of a chimney cannot be accurately observed on a draft gage. It is the maximum difference in pressure expressed in inches of water under the operating conditions as they exist, but with the one exception that the gases within the chimney are motionless. It is true that the flow of gases could be stopped by closing the damper, supposing that there is a tight damper. For a short time, a draft gage would then doubtless read not far below the theoretical draft, but as the gases would no longer be heated, they would cool more or less rapidly, and the draft gage reading would gradually fall to zero.

Loss Within the Chimney

When the gases within the chimney are flowing freely, the intensity of the theoretical draft is decreased by two losses of draft within the chimney:

1. Loss of draft due to velocity, or acceleration, h_v.
2. Loss of draft due to friction, h_f.

The theoretical draft less the amounts lost due to velocity and to friction is called the *available* draft, D_a,

$$D_a = D_t - (h_v + h_f) \qquad (3)$$

The loss of draft due to velocity, or the amount of draft necessary to accelerate the chimney gases, is given by the equation,

$$h_v = 0.000182 \frac{W^2 T_c}{A^2 W_c B_o} \qquad (4)$$

in which

W = Amount of gases flowing, lb. per sec.;
A = Cross-sectional area of the chimney, sq.ft.

The loss of draft due to friction in the chimney is given by the equation,

$$h_f = 0.000182 \frac{fW^2T_eLC}{A^3W_eB_a} \qquad (5)$$

in which

f = Coefficient of friction;

L = Distance between the bottom of the breeching opening and the top of the chimney, ft.;

C = Perimeter of cross-section, ft.

The coefficient of friction is doubtless constant regardless of the material of which the chimney is built, since in time the inside surface of all chimneys becomes coated with a heavy layer of soot. Most authorities assign to f a value of 0.016.

As an example, let us determine the theoretical and available draft of a chimney for the following conditions:

200 ft., height of chimney.
10 ft., diameter of chimney.
550 deg. F., observed temperature of chimney gases.
60 deg. F., observed temperature of outside air.
0.084 lb. per cu.ft., density of the chimney gases at 32 deg. F.
29.00 in. of mercury, observed atmospheric pressure.
90 lb. of gases passing per second.
180 ft., distance between bottom of breeching opening and top of chimney.

Solution: From equation (2), $D_t = 1.321$ in. of water.
From equation (4), $h_v = 0.099$ in. of water.
From equation (5), $h_f = 0.114$ in. of water.
Whence, from equation (3), $D_a = 1.108$ in. of water.

The available draft of a chimney must always be at least equal to the required draft, which is equal to the sum of the various losses of draft throughout the installation outside of the chimney; that is, through the fuel bed, through the boiler, through the breeching, through the economizer, due to turns or bends and due to a sudden enlargement of a section.

These various losses of draft will be discussed in a subsequent article.

Erroneous Equations Widely Used

In an equation commonly used for determining the theoretical draft of a chimney, it has been assumed that the density of the chimney gases is the same as that of the outside air. This assumption is wrong. The density of the outside air is 0.0807 lb. per cubic foot at 32 deg. F., while that of the chimney gases ranges between 0.084 and 0.088, and even greater. Similarly, an equation widely used for determining the available draft of a chimney neglects important items and makes false assumptions. A single factor is used to correct for friction and for the variation in the temperature of the chimney gases. The height of the chimney is confused with the length of gas travel therein; they are not always the same.

The most serious criticism that can be directed against such equations, however, is that they contain no term for the loss of draft due to velocity, or acceleration. This loss is important, and ordinarily its intensity is only a little less than the loss due to friction within the chimney.

Under normal conditions, the results as computed by such equations differ little from those given by the equations of this article, because experience has dictated suitable values for certain coefficients. For unusual conditions, on the contrary, methods not based on sound theory may lead to costly blunders in chimney design.

In equations (2), (4) and (5) all the factors can be either observed fairly accurately or computed, with the exception of the temperature of the chimney gases. It is a well-known fact that the temperature of the chimney gases decreases as the gases ascend, the temperature drop depending upon the thickness of the walls of the shaft, the materials of which the shaft is built, the condition of the interior wall surface, the tightness of the shaft against air infiltration, the height of the lining and the height of the chimney itself. In the great majority of operating chimneys it is impracticable to observe accurately the chimney-gas temperature with instruments, and for this reason it is well to make ample allowance for the temperature drop. This subject is complicated and comparatively little information is available.

The subject of draft is, as it should be, an important factor in steam-plant design and operation. The large draft losses through boilers and fuel beds, due to the higher boiler ratings and high combustion rates of modern plants, make it imperative that there be sufficient draft. The height of a projected chimney is dependent upon required draft throughout the installation, and after it is constructed it must produce the necessary available draft to overcome these losses. It is of the utmost importance that the chimney shall perform effectively, and too much stress cannot be laid on the necessity of exercising great care in every step of its design.

A Compressed-Air Oil Eliminator

An interesting detail in the construction of the Hele-Shaw-Beacham air compressor, described in *Engineering*, Vol. 140, No. 3123, Nov. 6, 1925, page 588, is the oil eliminator made necessary by the method of lubrication. Oil is atomized in the compressor intake by means not unlike the carbureting devices used in internal-combustion engine practice. This oil-charged air serves to lubricate the pistons and valves, and the oil is carried out in the discharge. To economize oil and to avoid the difficulties that would follow from the use of oil-laden air, an eliminator has been provided. Oil-saturated air enters the eliminator from the after-coolers. It first passes through a baffle plate with $\frac{3}{8}$-in. diameter holes and then enters a nest of vertical wires. This is made up of some 800 wires about $\frac{1}{16}$ in. in diameter, and 12 in. long, arranged in a nest $4\frac{1}{2}$ in. square. (This corresponds to a spacing of approximately $\frac{5}{32}$ in. between centers of wires). The particles of oil in the air strike these wires, on which they collect and run down into a sump at the bottom of the eliminator, from which oil is delivered through a small bore pipe and filter to the distributing valve system. The discharge compressed-air pressure of course furnishes motive power. In other applications a pump might be necessary.

In general the tendency in manufacturing plants is for the power demand to increase faster than the demand for process and heating steam. This in itself tends to reduce the percentage of the power demand that can be generated as a byproduct of the heating steam. A compensating trend is that toward increased throttle pressures, lower process pressures and increased prime-mover efficiency, all of which make it possible to obtain more power from a given flow of steam.

Locating Faults in Electric Elevators—Mechanical Equipment

An Outline of the Different Mechanical Troubles That May Develop in Drum- and in Traction-Type Elevator Machine and What To Do To Overcome These Difficulties

BY CHARLES A. ARMSTRONG

MECHANICAL troubles on electric elevators are not so numerous as are electric and in general are not of such a nature as to cause an immediate shutdown of the machine. However, these defects are in many cases of great importance so far as the safety of operation is involved, and therefore the

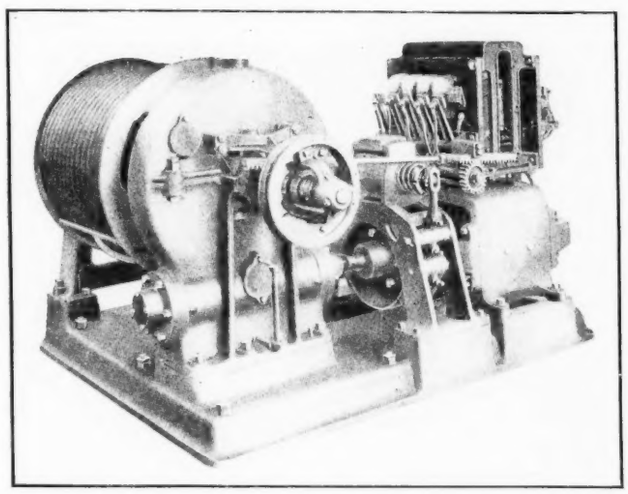


Fig. 1—Drum-type elevator machine

mechanical parts of the machine should be given as careful attention as the electrical.

The mechanical troubles that can develop on an electric elevator depend upon the type of machine. With a geared-type drum machine, Fig. 1, or the geared traction machine, Fig. 2, the motor and gears are common to both types and what is said regarding one applies to the other. Noisy operation of the motor is a common defect. This may be due to the rotating element's being out of balance or the bearings worn so as to let the armature or rotor rub on the polepiece or stator core. The latter is more likely to occur with induction motors than with direct-current machines, on account of the close clearance between the rotor and stator of alternating-current machines.

Another cause of noisy operation is the armature or rotor working loose on the shaft. In elevator service the rotating element of the motor is subjected to reverse stresses, due to starting in one direction and then in the other, and the braking action during stopping. If there is any slight movement of the armature or rotor on the shaft, it will soon wear to allow considerable motion. When there is any movement between the rotor and the shaft, it should be corrected as soon as possible by shimming up under the key or by fitting a new key. If the repair is not made at an early stage of the trouble, both the key and keyseats will become worn and it will be necessary to recut the keyseats and use a larger key. If the rotor has not a large shaft and a substantial key, it may be found difficult to prevent the rotor from working loose on the shaft. This was particularly true of some of the older types of alternating-current motors that were constructed with short large-diameter rotors.

The motor out of line with the wormshaft is one of the most common causes of noisy operation. This is a dangerous condition if the motor is much out of alignment, since the bending strains set up in the rotor shaft at the brake-wheel coupling may break the shaft. If this were to happen with a heavy load in the car when in the down motion, the motor would be acting

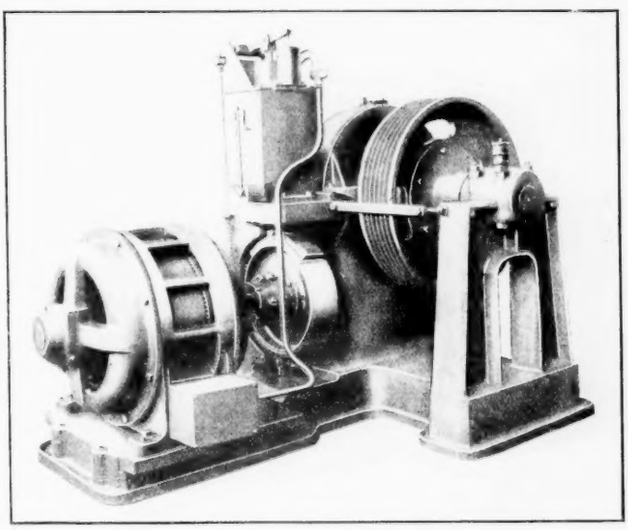


Fig. 2—Geared-type traction elevator machine

as a brake to keep the load under control. Should the rotor shaft break, the load would be released, and since the mechanical brake will not be applied until the operator centers the car switch, there is the possibility that the car may reach a high speed or even get out of control or the safeties set on the car before the operator acts. In cases where dynamic braking of the motor is used to assist the mechanical brake in stopping, if the armature or rotor shaft breaks, only the mechanical brake is available for stopping the machine.

The brake and brake wheel should be given careful attention, for it is this part of the machine that stops the car, and if the brake is not in proper condition,

not only is the service rendered by the elevator impaired, but a hazard to life and property is created.

It should be ascertained if the brake wheel and coupling are properly secured to the motor and worm-shaft. Two of the common troubles with a brake are, it does not stop the car quick enough or it stops it too quickly with an unpleasant jar to the passenger. The failure of the brake to stop the car within proper limits may be due to worn or oil-soaked and dirty brake line. Putting a new lining in the brake shoes should not be attempted except by an experienced mechanic. Unless the lining makes a good fit with the shoes, it

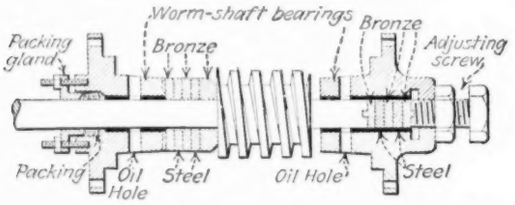


Fig. 3—Wormshaft, showing bronze- and steel-disk thrust bearings in place

will have an uneven surface and will touch the brake wheel at only a few points. As a result the effectiveness of the brake will be greatly reduced.

When the brake linings are in good condition and the brake does not properly stop the car, the cause is then in the mechanical adjustments or in the dynamic-braking circuit in the controller. The brake should be adjusted so that when it is released, the shoes just clear the wheel. Then the tension springs on the weight should be adjusted to give the desired stopping period.

Where dashpots are used on the brake to control the rate of application, it is essential that they are kept clean and in good condition or their action will not be constant, which will cause differences in the application of the brake. If the dynamic-brake circuit should open, it will, with the same mechanical brake adjustment, allow the car to slide. If the mechanical brake is adjusted to stop the car within reasonable limits under this condition, an unpleasant jar to the car will result. A short-circuit in the dynamic resistance will stop the car too quickly, but this will generally be accompanied by sparking at the motor's brushes. Therefore, when trouble is being experienced with a brake, careful consideration should be given to the electric circuits as well as the mechanical features.

On some types of brakes it is possible to have one shoe applied with greater force to the brake wheel than the other. A brake adjusted this way will stop the car suddenly in one direction and allow it to slide in the other. On some of the old-type machines with no, or with very little counterweight and a brake with only one shoe, it is impossible to obtain a satisfactory adjustment of the brake.

On alternating-current equipment with two-speed motors, on stopping the high-speed motor is cut out and the slow-speed motor is cut into service. This motor acts as a brake to slow the machine down to correspond to the motor's normal speed. If the control equipment gets out of adjustment so that the slow-speed motor is not cut into service for slowing down, then the entire work of stopping the machine is thrown on the mechanical brake, with the result that it will be difficult to make good stops, and the extra work put on the brake may cause it to heat excessively.

At best the stopping of elevators driven by alternating-current motors is not any too satisfactory. In the high-speed direct-current machine the elevator is brought almost to a stop by the motor before the mechanical brake is applied. In this equipment the desired application characteristics can be designed into the electrical circuits of the brake, so that the car will be brought to rest smoothly under almost any conditions of load and speed. On alternating-current equipment the machine cannot be slowed down by the motor below that corresponding to the speed of the slow-speed motor, which is usually one-half or one-third of full speed. Below this speed the rest of the slowing down and stopping must be done by the mechanical brake. On alternating-current equipment the brake does not lend itself to the fine adjustments as does the direct-current brake. Therefore, it could hardly be expected that as smooth stopping of the elevator would be obtained with alternating-current equipment as with direct current.

On the worm-gear type of drum or traction machine the thrust bearings are one of the chief sources of trouble, particularly in the older types of machines. These thrust bearings may be of the disk type, Fig. 3, made up of bronze and steel disks, or of the ball type, Fig. 4. In the latter the ball thrust bearings are shown at *T*. If the disk thrust is properly designed and installed and kept well lubricated, the wear should be relatively small. Whatever wear there is, must be taken up by the adjusting screw. If the wear is all on the

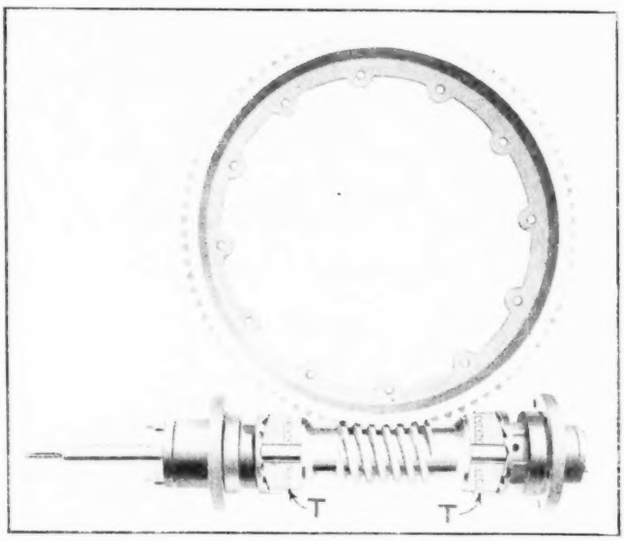


Fig. 4—Wormshaft, showing ball thrust bearings in place

back thrust bearing, then each time the adjustments are made the worm and motor shaft are brought back to their original position. When the wear is on the front thrust bearing, then the wormshaft and motor shaft is being pushed toward the outboard bearing of the motor. In this case care must be exercised to see that the motor shaft is not pushed far enough endwise to transfer the thrust from the thrust bearing to the outboard bearing of the motor. If the outboard bearing of the motor is allowed to take the thrust, this bearing may heat, or in severe case the thrust may be sufficient to break the bearing bracket.

In some of the older-type machines one of the thrust

bearings was put on the outboard bearing of the motor, but on these machines the motor was designed for such service. This arrangement did away with the thrust bearing on the front end of the wormshaft, which cannot be got at without taking the wormshaft out, which is generally a job that requires considerable time.

With the ball or roller thrust bearings, one of the chief difficulties has been chipping of the balls or rollers. The troubles have been very largely overcome in the more modern designs. Chipping of the balls or rollers was not all due to defects in these parts, but in the adjustment. In assembling the machine all the end play can be taken out of the wormshaft and still have it turn freely. This did not provide for expansion of the wormshaft when its temperature increased during operation, and the expansion no doubt put sufficient load on the balls to crack them. In adjusting a ball thrust bearing, about $\frac{1}{32}$-in. play should be allowed for expansion of the wormshaft.

In addition to the two types of thrust bearings shown, a great variety of other types have been developed, but for the most part they differ in features of application and adjustment rather than in principle. There has been used a number of different types of adjustable thrust bearings for the motor end of the wormshaft. Another scheme that has attracted a great deal of attention is that of locating both thrust bearings on the rear wormshaft bearing, where they are easily accessible for making repairs and adjustment.

On tandem-geared machines, Fig. 5, the gears not only mesh into the wormshaft, but they mesh into each other, as can be seen in the figure. In this arrangement the thrust is taken in the gears and wormshaft and no thrust bearings are required. Assume that the right-hand gear, which is attached to the drum, has a tendency to turn clockwise owing to the difference

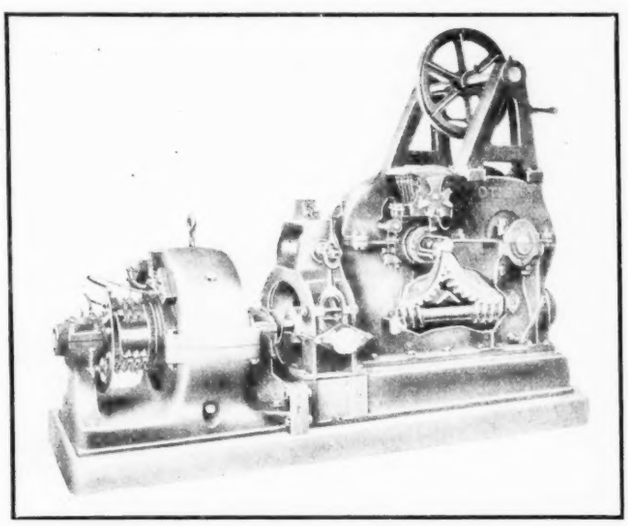


Fig. 5—Tandem geared drum-type elevator machine

in loading of the car and counterweight cable on the drum. This would tend to thrust the wormshaft to the left and turn the left-hand gear in a counterclockwise direction. This gear tending to turn in a counterclockwise direction sets up a thrust in the wormshaft to the right, which opposes the thrust set up by the other gear, consequently the worm shaft cannot move on end in either direction. This arrangement works out very well as long as the gears are not worn, but as soon as these parts begin to wear it allows a backlash in the gears, which permits a certain amount of end motion of the worm shaft. There is no way that this end thrust can be taken care of except by installing thrust bearing or renewing the gears, the latter being an expensive job. The more the gears wear, the greater the wormshaft end play becomes.

No attempt should be made to work on the wormshaft

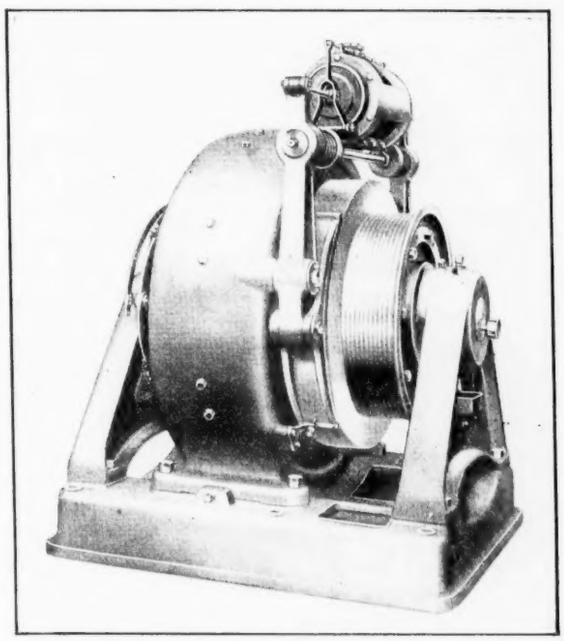


Fig. 6—Direct-traction type elevator machine

or thrust bearings until either the car or the counterweight is bottomed in the hoistway, whichever is the heavier. In modern machines this will always be the counterweight. If the gear is allowed to get out of mesh with the worm, the counterweight being the heaviest will fall, with disastrous results unless they are supported from the bottom of the hatchway. When work is to be done on the drum-shaft bearings the counterweight should be supported from the bottom of the hatchway and the car slung from the overhead beams, using two chain falls for the latter.

Where the gear and worm do not mesh properly, or when they are not properly lubricated, they may begin to cut; in which case the gear and worm operates with a loud roaring noise and vibration. This trouble can be cured by putting one or two pounds of sulphur in the gear case with the oil and letting it remain until the operation of the gears becomes normal. The length of time will depend upon the elevator service. If the machine is in continuous operation, then one-half to one day's time will be sufficient to put a good wearing surface on the gear and worm. After this the oil is removed from the gear case and the case and gear thoroughly cleared, before a new supply of oil is put in. Chipped balls in a thrust bearing will cause the machine to make a noise similar to that obtained when the worm and gear are cutting, but nothing will cure the thrust-bearing trouble except renewing the defective parts.

When it was the general practice to key the worm gear and drum to the drum shaft as separate units, considerable trouble was experienced with these parts

working loose on the shaft. In modern practice the drum is keyed to the shaft, but the gear is bolted to a heavy flange extension on the drum's hub. With this arrangement the only source of trouble is the bolts working loose, which hold the gear to the drum. If the bolts are properly tightened and the nuts locked in place, loose gears are a rare occurrence. However, on inspections, this part of the machine should be looked at carefully, since a failure at this point would be dangerous, as the car would be free to go in whichever direction the excess weight, in the counterweight or car, would take it.

Wearing of the Grooves

On traction machines using metal sheaves, either of the geared type, Fig. 2, or the direct type, Fig. 6, the wearing of the grooves in the traction sheave to different diameters is a source of trouble, as it affects the life of the cables. Where the grooves have unequal diameters, the ropes on the smaller-diameter grooves must slip a certain amount to maintain the same speed as those running on the larger-diameter grooves. This slipping tends to increase the wear and make the conditions worse. Not only are the grooves worn, but the cables will wear to different diameters.

When the grooves become worn, it is the practice to remove the sheave, take it to a machine shop and turn the grooves to the proper shape and equal diameter in a lathe. In some cases the lathe tool is mounted on the elevator machine and the grooves trued up in place, using the motor to drive the sheave. Either method requires shutting down the machine and removing the cable from the sheave. Turning the grooves to the same size and diameter does not completely remove the trouble. Owing to the cables being of unequal diameters, on V-groove sheaves the smaller cables will go down deepest in the grooves and there will be a differential wear between the cables and grooves. Therefore, when the grooves are trued up the cables should be cleaned up with a file when the safeties are released.

Renewing of the Cables

The cables on an elevator do not generally give any trouble, but they should be renewed periodically before their condition becomes unsafe. This is generally done when six or more broken wires are found in one lay of any one strand. The cables should be inspected where they are attached to the sockets as well as in the main body of the cables. It not infrequently occurs that very few broken wires will occur in the main body of the cable, but a number will be found broken at the sockets. The size of sheaves, lubrication of cables, size of cables and the material from which they are constructed, number of strands and wires per strand, etc., are questions that offer a broad field of discussion that is outside the scope of this article.

Noisy operation of the car is generally due to worn guide bearings, lack of lubrication on the guide rails or the guide rails rough or out of line. The first two are the chief causes of noise. It sometimes occurs that when the safeties are set, they scar the guide rails at the point of application. These spots should be cleaned up with a file when the safeties are released.

As has already been mentioned, the mechanical faults that may develop in an elevator machine will vary somewhat with the type of equipment. But the foregoing will act as a guide to the most common defects. In most cases the mechanical defects that develop on elevators are quite obvious to a good mechanic, which is not always the case with the electrical troubles. Although the mechanical troubles do not vary widely on the different classes of machines, there is a great difference in the electrical faults that may develop.

Work To Compress Air

Once an air compressor is thoroughly warmed up to uniform operating conditions, the work delivered to each pound of air is equal to the constant pressure specific heat of the air, times the difference in temperature between discharge and intake, plus the aggregate heat removed in cylinder jackets, intercoolers, aftercoolers and the like. Of course the work delivered to the actual compressor is in excess of this theoretical work requirement, due to the work required to run the compressor as a machine, and to losses, such as leakage, heat, etc.

The ease with which this quantity can be determined makes it very attractive as a rough means of figuring the compressor performance. Readings of a few thermometers and of water meters on the cooling-water lines will suffice to furnish data for the calculation of the work actually delivered to the air in the compressor. A comparison of this with the input to the compressor determined from steam-cylinder indicator cards or from meters measuring electrical energy delivered to the driving motor gives an indication of the efficiency of the compressor, and variations in this quantity serve as a check on the condition of the compressor with respect to such matters as friction and leakage.

It should be noted that this calculated quantity is not the work corresponding to a theoretical or ideal compressor operating with isothermal or adiabatic compression. It is the work actually done in the real compressor, subject to error due to the fact that the heat removed in the jackets is not the total heat loss. Heat is removed and carried away through the metal of the machine and radiated to the room. In addition to this there are small influences, due to air velocity, and losses due to leakage, and the like. For the air that is actually delivered, however, the work expended is properly calculated by this simple method.

The natural oxide that forms on the outside of an aluminum wire and makes it so difficult to solder, is an electric insulator. Aluminum wire has been used in coils with no other insulation than the oxide on its surface. In these cases the oxide coating on the wire was strengthened by an electrolytic process. Although the oxide film was exceedingly thin, it was capable of withstanding 500 volts without failure and was not affected by temperature. Small coils wound with this wire have been heated to a temperature above the melting point without falling to pieces. The coating is tough and two wires have been crossed and pressed together until they were not thicker than one, without the insulation failing when 250 volts were applied. This oxide is highly abrasive since any relative movement between the two wires would cause the oxide to fail as an insulator.

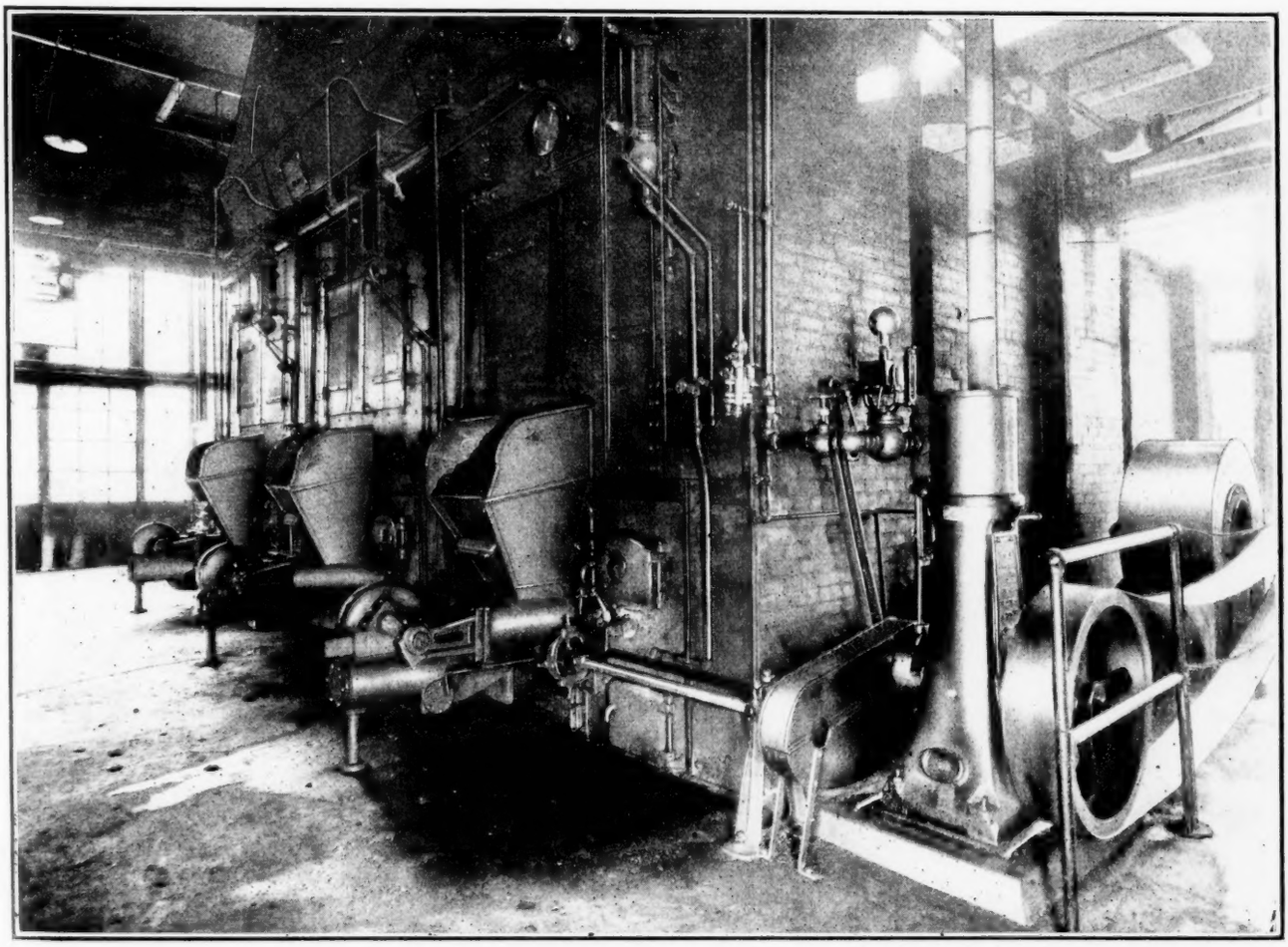
Stokers Pay Big Dividends in Heating Plant

IN A three-boiler plant operating during the heating season of seven months, the installation of stokers saves more than $10,000 over hand firing and the use of oil for a short period. On a straight coal basis the minimum annual saving is placed at 73 per cent of investment in stokers.

IN A relatively small plant containing three hand-fired return-tubular boilers, the installation of stokers usually has been considered of doubtful advantage, owing to the charges on the capital investment offsetting approximately the saving effected by the stokers. In times past, when fuel and labor were to be had at a lower cost than at the present day, this engineering generality had a basis of truth and could have been accepted without much question. But times have changed. Fuel costs are higher, so that a saving in tonnage means more. Wages have increased and stokers have been improved not only in the economy of operation, but also in mechanical design better adapted for inferior grades of coal. This makes possible, besides a reduction in tonnage, the burning of a cheaper fuel.

As an example of the surprisingly large saving that stokers will effect in one of these relatively small plants, the case of the Detroit Steel Products Co. may be cited. This company is the manufacturer of "Fenestra" steel window sash and "Detroit" automobile springs, with a plant covering several acres of ground on East Grand Boulevard, Detroit. Current is purchased for light and power, but the plant has been heated with steam generated at 100 lb. pressure in three 72-in. by 18-ft. horizontal return-tubular boilers set in one battery. For several years after the plant was built, these boilers had been hand fired during the heating season of about seven months per year.

In 1922 an oil-burning system was installed on one of the boilers and oil was purchased at about 6c. per gallon delivered, but the cost of operation was found to be excessive and hand firing of coal was resumed



Stoker installation under return-tubular boilers at plant of Detroit Steel Products Company

for the rest of the heating season. Rapid expansion of the manufacturing plant brought about a condition that taxed the heating plant to the limit during severe weather. It was then a question of adding more boilers or increasing the steaming capacity of the existing equipment by installing mechanical stokers. About this time there was a movement in Detroit to pass a smoke ordinance. With hard firing the boiler installation smoked badly, which also served as an argument for mechanical stokers.

In due course the decision was made to so equip all three boilers before the opening of the next heating season. Single-retort Detroit underfeed stokers, 6 ft. wide by 5 ft. 6 in. long with a grate area of 33 sq.ft.,

TABLE I—COMPARATIVE COSTS OF HEATING

	1922-23	1923-24
Cost of fuel oil	$4,969.25	$0.00
Cost of coal	17,869.29	12,393.56
Cost of boiler-room labor	3,771.62	3,963.81
	$26,610.16	$16,357.37
Difference favoring stokers		$10,252.79

TABLE II—COSTS OF OPERATING HEATING PLANT WITH AND WITHOUT STOKERS

Coal and equivalent in fuel oil (1922-23), tons		3,767
Coal burned during season (1923-24), tons		3,075
Coal saving by use of stokers, tons		692
Coal saving in per cent		18.4
Average cost at mine per ton mine-run coal (1923-24)		$1.75
Average cost at mine per ton of screenings (1923-24)		1.15
Difference in price per ton of fuel		$0.60
Average cost per ton of screenings delivered in bin		$4.03
Saving to be credited to stokers for season 1923-24:		
692 × 4.03 = $2,789.00		
3,075 × 0.60 = 1,845.00		
Saving in ash haulage 36.00		
Total saving		$4,670.00
Complete cost of stokers, $5,400		
Maint., depreciation, insurance, taxes, etc... $540.00		
Extra labor expense 192.00		
Total		$732.00
Net savings		$3,938.00
Saving in per cent of investment		73

were selected and installed with a headroom of 7 ft. from the floor line to the shell of the boiler, which gave a combustion space of about 5 ft. above the grate. One forced-draft fan was provided to serve the three boilers, and it is belt driven by a 7x7-in. vertical engine which through a silent chain also drives the power shaft of the stokers. A pressure-type regulator controls the speed. All this equipment, including the stokers, blower, engine and furnace brickwork, cost $5,400.

At the end of the season access was had to the books, and the actual auditor's costs of fuel and boiler-room labor for the season were compared with those of the year previous. Table I shows a difference in favor of the stoker-fired plant of $10,252.79, notwithstanding the fact that the temperature averaged 3 to 4 deg. colder than it had during the previous winter and that the heating load had been increased about 10 per cent by the addition of a new building containing about 10,000 sq.ft. of heating surface. This large difference was attributed to the lower cost of fuel and the increase in operating efficiency due to the use of stokers. Except for a few of the coldest days in the season the new arrangement made it possible to carry the load on two boilers.

However, it was realized that oil made a costly fuel and that a lower-grade coal could have been burned on the hand-fired grates than actually had been used principally to eliminate the smoke nuisance. It was therefore decided to determine the approximate saving had average mine-run coal been burned during the heating season of 1922-23. The oil burned in the fore part of the season was reduced to its equivalent in coal, and the total tonnage for the season was found to be 3,767 tons, as compared to 3,075 tons for the stoker-fired plant during the season of 1923-24. As indicated, the reduction in fuel consumption was 692 tons per season, or 18.4 per cent. The average cost of mine-run coal, such as would have been required by the hand-fired grates, was $1.75 per ton for the season of 1923-24, and the average cost for screenings, such as were burned on the stokers during the same season, was $1.15, or 60c. per ton lower. These are mine prices, and the cost of freight and unloading was assumed to be the same in both cases.

Computation showed that the average cost of coal per ton delivered in the bin was $4.03. To obtain the saving in fuel to be credited to the stokers, the excess of hand-fired over stoker tonnage was multiplied by the foregoing figure, the total consumption of the stokers by the 60-cent differential and an addition of $36 made for a saving in ash haulage, giving a total in favor of stoker operation of $4,670. From this was deducted an overhead charge of 10 per cent on the investment, including maintenance, depreciation, insurance and taxes, and an extra labor expense of $192, leaving a net saving of $3,938, or in round figures the saving effected during a seven-month season of stoker operation over previous hand-fired conditions, amounted to 73 per cent of the total investment in stokers and auxiliary equipment.

The presence of air in a refrigeration system may be the result of leakage into the system at a time when a vacuum was formed in one part or another, or the air may have remained from the time when the system was filled with ammonia. When repairs are to be made, the part of the system to be repaired is pumped to a vacuum to remove the ammonia before it is opened. In a similar way the air in this part is exhausted before ammonia is admitted. A perfect vacuum is impossible, and this process always admits some air to the system, though it may be only a small amount if care is exercised and the vacuum is good.

Powdered fuel is so young in its general application to boiler furnaces that there are still marked differences of opinion among engineers as to the relative suitability of the unit mill and centralized systems to various conditions. So far the centralized system has been adopted in most of the large installations, while unit mills have predominated in small and medium-sized plants. Advocates of the unit mill for large plants as well as small, are finding encouragement in the remarks of C. F. Hirshfeld at the recent Midwest Power Conference. Mr. Hirshfeld pictured the unit mill as a worthy competitor of the central system for central-station use.

For thermometers measuring temperature of circulating water it is desirable to have a bulb length that will project several inches inside of the pipe so as to obtain a true temperature instead of the temperature of the outer stream of water, which would ordinarily be the case where a standard thermometer is employed. It is possible to carry this to extremes, however, and it is quite probable that, in most installations, a bulb projecting 6 in. into the piping would be entirely adequate, especially where the water has had a chance to mix after leaving the condenser and before reaching the thermometer.—*N.E.L.A. Prime Movers Committee.*

Hydraulic-Turbine Governing —Commercial Practice

Governor Traversing Time—Rating of Self-Contained and Actuator Type of Governors —Commercial Regulating Standards—Electrical Considerations— Inherent Speed Changes with Changes in Load— Making Governor Adjustments

By S. LOGAN KERR
Assistant Hydraulic Engineer, I. P. Morris Department, The William Cramp & Sons Ship & Engine Building Company

ONE of the features of hydraulic turbine governing that is the subject of much discussion is the time required for the governor to move the turbine gates through a full stroke either in closing or opening, known as the traversing time. It is this rate of gate movement that fixes the amount of speed variation for given load changes and it also determines

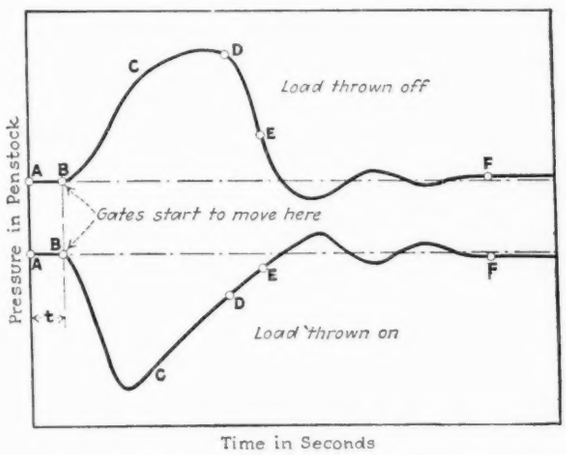


Fig. 1—Comparison of rise and fall in penstock pressure with respect to time

the rise or fall in pressure in the penstock leading to the turbine.

To determine the governor traversing time, consideration must be given first to the hydraulic conditions of the installation. With the head and capacity of a hydro-electric plant established, physical limitations usually fix the length and type of conduit to be used, while the diameter and thickness of the penstock are affected by economic considerations and by the maximum allowable rise and fall in pressure. Excessive water hammer in a penstock due to quick governor action is not desirable, and for most installations a rise in pressure not in excess of 50 per cent above normal following complete loss of the load, is generally considered good practice.

With oncoming loads the fall in pressure due to acceleration of flow in the penstock becomes of great importance. Particularly is this true, when the profile of the penstock is such that a vacuum may be formed at the high points, rendering the danger of collapse or the breaking of the water column an important consideration. The interesting feature of the fall in pressure is that the maximum decrease in pressure below normal occurs almost immediately after the gates start their movement and not toward the end of the movement, as is usually the case with the rise in pressure, as indicated in Fig. 1. It is therefore essential to limit the opening stroke, even on fractional loads, to a safe rate computed from actual flow conditions.

In the case of high-head plants the flow line is usually of considerable length and may consist of canals or tunnels in addition to long penstocks. To regulate satisfactorily a turbine supplying variable load under these conditions requires a very heavy flywheel effect to prevent excessive speed changes, as a short governor traversing time would be virtually impossible owing to the extremely severe water-hammer conditions that would develop.

Use of Auxiliary Relief Valve

In certain installations the rise in pressure can be taken care of by providing an auxiliary relief valve which is opened by the governor as the gates are closed, as shown at *A*, Fig. 2. This valve opens and bypasses the water when the turbine gates close and reduces the rate of change in velocity of the water to a minimum. Relief valves, however, cannot care for the fall in pressure following an oncoming load, and thus fail to prevent excessive drop in speed. By far the best results are obtained by installing a surge tank as close to the turbine as possible.

The use of a properly designed surge tank eliminates excessive water hammer and also permits a much faster governor time than could otherwise be utilized with safety. This results in much better regulation, but even under these conditions it must be expected that the speed variations above or below normal following sudden load changes will be somewhat greater than could be obtained on plants having relatively short water passages.

In the case of low-head plants without penstocks the governor timing can be made much shorter than for high-head plants, but care must be taken not to move the gates fast enough to break the water column within the unit itself, and thus cause severe surging in the draft tube. The inertia or momentum of the water column in the draft tube below the turbine is quite appreciable and forms a considerable part of the total water column. For certain designs of draft tubes having long diffuser sections, the tendency of this water column to break below the runner, following a loss of load, is quite marked. In high- or medium-head plants the governor time is usually a function of the penstock

length and for practical purposes should not be less than that given by the following formula:

$$T = \frac{LV}{12H}$$

where

T = Total governor traversing time in seconds;
L = Total length of the penstock in feet plus one-half of the turbine's volute casing and an allowance for the draft tube[1];
V = Average velocity of the water column, in feet per second, at rated load;
H = The normal effective head in feet.

The time resulting from this formula will result in a maximum rise in pressure above normal of approximately 50 per cent of the total head and hence should be utilized as the minimum allowable time for the gates to move through their full stroke.

It is usually desirable to keep the minimum governor time in excess of two seconds, as little actual gain is secured by reducing it below this value. The use of a governor time less than the recommended minimum value may result in wider speed variations than with a slower time. This is due to the rise or fall in pressure being great enough to increase rather than decrease the net difference between output and demand and thus discount any benefits that might be expected from a faster traversing time.

The rating of the governor is usually given in foot-pounds capacity at a certain specified pressure of the operating fluid. Smaller sizes of governors of the self-contained type have the operating cylinder and the governor proper built as an integral unit. It is from this type that the rating in foot-pounds originated,

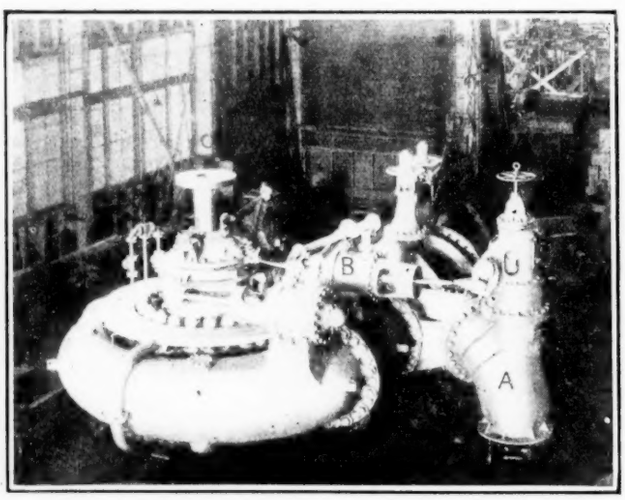


Fig. 2—Relief valve A is connected mechanically to piston in gate-operating cylinder B

since the size of the operating cylinder is a direct function of the capacity required to move the gates, and therefore, fixed the physical dimensions of the governing unit. Governors of this type are made in varying sizes from about 1,000 to 40,000 ft.-lb., or possibly higher in special cases.

In case of actuator governors where the operating cylinders are located on the turbine proper and the governor is built as a separate unit containing the fly-balls, compensating mechanism and valves, the rating of the governor assumes a different aspect. The operating cylinders must be designed to overcome satisfactorily the hydraulic forces and mechanical loads on the turbine gates. The so-called governor capacity in foot-pounds can be calculated from the volume of these cylinders and the pressure of the operating fluid. The capacity of the actuator, however, is not necessarily a direct function of the volume of the gate-operating cylinders, since the governor valves are fixed in size by the rate at which the governor fluid passes through

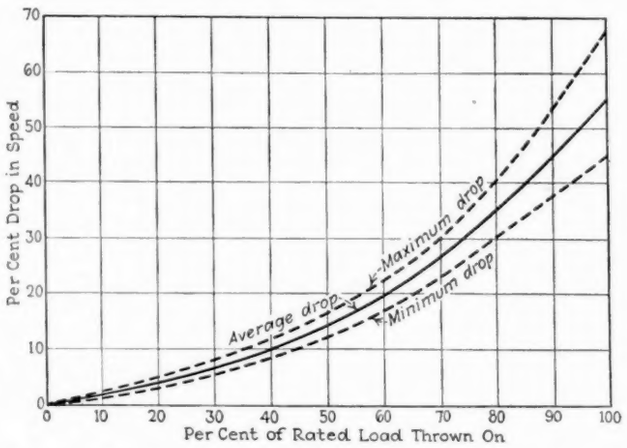


Fig. 3—Curves showing typical hydraulic-turbine speed variation for loads thrown on from zero

Range of heads 15 to 90 ft. on units of capacities up to 10,000 hp. rating.

them, rather than by the total quantity of fluid to be handled. Hence, the rating should be in foot-pounds per second, rather than total foot-pounds as commonly employed. For example, consider a governor system with a required capacity of 200,000 ft.-lb. If a full stroke must be made in two seconds, the actuator should have a capacity of 100,000 ft.-lb. per second, but if a four-second governor time is required on account of hydraulic conditions, then the actuator need only be large enough to handle 50,000 ft.-lb. per second. It is therefore evident that the governor traversing time should be fixed as closely as possible both from a hydraulic viewpoint and also from the governor viewpoint before the plant is constructed.

The required governor capacity of a turbine is a function of the type of unit, its size, and the head under which it is to operate, and detailed calculations are required to design accurately the operating mechanism and the governor for each specific installation. There is, however, an approximate formula that serves in a general way to fix the capacity of the governor for preliminary purposes:

$$\text{Governor capacity} = \frac{HP. \times K}{\sqrt{H}}$$

in which $HP.$ is the rated capacity of the unit in horsepower, H is the normal head in feet and K is a constant of 40 to 50.

The governor capacity as actually required may be somewhat larger than that obtained from the formula given, depending on design considerations of the individual installation, but for self-contained types of governors it usually gives close to the capacity required.

The turbine or governor manufacturer is called upon to make certain guarantees of speed regulation for the proposed installation, and calculations are made, based

[1]Where the head is over 100 ft., the draft tube may be neglected.

on the hydraulic conditions, the recommended flywheel effect and governor time. To place all such guarantees on an equal basis, certain assumptions are made with regard to the conditions under which the governor is to operate, which are: (1) Turbine operating as an isolated unit; (2) water-rheostat load; (3) no outside assistance from connected flywheel effect; (4) load changes thrown on from zero or off to zero.

With these standard considerations the guarantees may be computed with a fair degree of accuracy with any one of several approximate formulas. Actual tests with the units operating in parallel with the system usually show somewhat better results than the guarantees owing to the margin allowed by the manufacturer and to the benefits obtained from the flywheel effect of other units on the system. For special conditions detailed calculations can be made, based on a lengthy study of the hydraulic phenomenon and energy change, but for all practical purposes the approximate short-cut formulas are sufficiently accurate.

In order to make guarantees of speed regulation, it is essential that complete information be available concerning the hydraulic conditions of the flow line leading to the turbine and the recommended flywheel effect of the generator as well as the normal governor traversing time to be used.

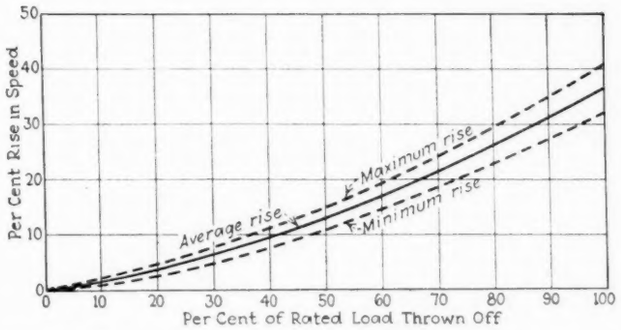


Fig. 4—Curves showing typical hydraulic-turbine speed variation for loads thrown off to zero

Range of heads 15 to 90 ft. on units of capacities up to 10,000 hp. rating.

With the various physical limitations of the power plant fixed by practical consideration, the governor timing established, the speed variations for ordinary load changes are limited to a practical degree by the amount of flywheel effect installed in connection with the generator rotor and turbine runner. It is usually considered well within the limits of standard practice to fix this flywheel effect on the basis of allowing a variation in speed of 15 per cent below normal when a load equal to 50 per cent of the rated capacity is thrown on the unit from zero. This in turn fixes the degree of speed variation for the remaining percentages of load change. Fig. 3 shows a curve of percentage drop in speed below normal for various percentages of rated load thrown on the unit. The solid curve marked "Average drop" is obtained from the guarantee specifications of 15 or 20 installations with heads ranging from 15 to 90 ft., and unit capacities up to 10,000 hp. The broken curves marked, "Maximum and minimum" show the range in these guarantees for the same plants. For the 50 per cent load thrown on, the range is from 12.2 per cent to 16.5 per cent drop in speed below normal, the difference being due to variations in recommendations for the flywheel effect of the generator. Fig. 4 shows corresponding curves for rise in speed above normal for various percentages of the rated load thrown off to zero. In all cases the governor returns the speed to near normal after the load change.

For large-capacity units or for plants involving a moderate length of penstock the general trend of speed changes will be about the same as shown in Figs. 3 and 4. As there are special cases, speed-regulation guarantees may vary from the usual range.

Inherent Speed Drop

To operate satisfactorily two or more alternating-current generators in parallel and to prevent interchange of load between units, it is necessary to have an adjustment on the governor to give a slight reduction in speed as the load increases. This feature is variously called isochronous speed regulation, paralleling adjustment, or inherent speed drop, but perhaps the last term best describes its function.

Consider a single unit on an isolated system operating at normal speed with zero load. As the load builds up, and without attempting to change the speed setting of the governor, the frequency will gradually drop in proportion to the load carried, and, when full load is reached, will be considerably below normal, depending upon the setting of the governor.

The degree of inherent speed drop normally required varies from 2 per cent to about 6 per cent, depending on the system characteristics. The various generating units share the load changes in the inverse proportion of the amount of inherent speed-drop setting on the individual governors. By this means certain units may be made to take the majority of the regulation, leaving the other units relatively unaffected.

In actual practice the operator compensates from time to time for the variation in speed due to this feature, but unless severe load changes take place, changes in frequency will be so slight as to be unnoticeable.

Governor Adjustments

The co-ordination of all the functions of a governor —sensitiveness, stability, primary and secondary compensation, timing and inherent speed drop—is essential to satisfactory regulation. The adjustment of the timing and compensating devices cannot be made a standard for all installations, nor can the inherent speed drop be the same for all cases, because the service demanded of the governor is almost always different in each particular power system.

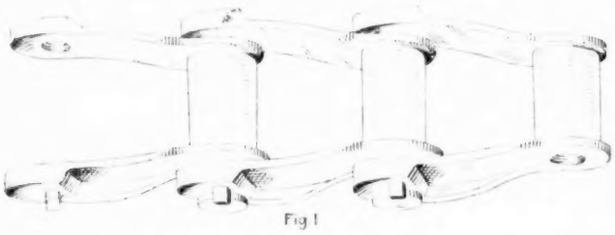
If the governors are required to handle large changes of load in proportion to the capacity of the units, a totally different setting must be made from that which would be the case if the governors were to operate on steady loads and were required to handle only a small portion of the regulation. The character and type of load on the system may call for widely different response to speed variations and this, too, requires consideration. The hydraulic conditions in the plant play an important part in the compensation adjustment, as the settings for high-head Francis wheels are different from those required for low-head turbines, and for propeller-type units radically different from those required for other types.

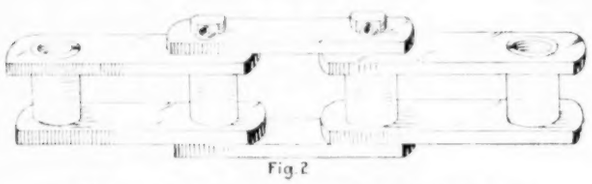
Each plant is, in itself, a problem of correct adjustment which can be made only with the hearty co-operation of the operating staff in determining and agreeing upon the type of regulation that is most adapted to the particular requirements of the installation.

Application of Chain Drives

Various Types of Link Belts and Silent Chain Drives and How They Are Used in the Power Plant

IT WAS not so long ago that chain drives were exclusively made up of sprocket chains. These consisted of links that in passing over the driven and driving wheels, were engaged by teeth or sprockets. Such sprocket chains are much used for such services as drives for coal elevators, coal conveyors, water screens and other slow-moving machines; they are of two general types, detachable link and roller chains. The first, Fig. 1, consists of malleable cast-iron links that hook together. The chief advantages are cheapness and ease of repair. Since the sprocket tooth contacts with the crossbar of the link, causing wear, renewal is more frequent than when a harder surface is provided. In order to give a reasonable life the speed should not exceed 300 ft. per minute.





Figs. 1 and 2—Types of Sprocket Chains

Roller chains, one of which is shown in Fig. 2, are now much in evidence, inasmuch as the rollers can be hardened and, when worn, can be replaced at a small cost. Chain speeds may be fairly high, up to 700 ft. per min., although 500 ft. is a better limit, considering wear, etc.

Sprockets of less than 15 or more than 60 teeth should be avoided wherever possible, and for best results the gear ratio should not exceed 4 to 1. The center-to-center distance between the shafts should be not less than one and one-half times the diameter of the large sprocket wheel.

The need for a transmission device capable of operating at a fairly high speed that would maintain a uniform velocity ratio between the driving and driven shafts encouraged the development of the silent chain such as shown in Fig. 3.

The silent chain is suitable for drives of almost any length, but its high first cost precludes its application for shaft center distances of over 10 or 12 ft., above which belts, save in exceptional cases, are more economical. Frequently, even where the center distance is such that gears could be used, a silent chain is preferred. Broadly speaking, however, the chain finds its logical field in those drives where the center distance is such that the gears would be large and expensive, and where a belt drive cannot be applied because of the necessity of exact phase relation between the driving and driven shafts.

Most of the silent chains make use of a pin bearing, as at *A* in Fig. 3, of a design to give a rolling instead of a sliding motion as the chain teeth move about the gear. In fact, to obtain a high efficiency such a rolling contact must be used. It also reduces the lengthening of the chain through wear of the pin joints.

As compared with belt drive the silent chain will stand a heavier load per inch width and may be used on shorter centers. Slippage is absent, and when the teeth are properly designed the velocity is practically uniform. Silent chains are usually more quiet than are gears and may be operated at high speeds. By reason of the "give" in the chain, shocks are not as readily transmitted as with gears.

Unlike a belt drive, where the slack should be on the top, either top or bottom may be the slack side in a chain drive. However, if the center be close, the bottom should be made the slack side to insure proper engagement of the teeth. When the gears, or sprockets, are of small diameters, if the top is run slack it may touch the lower strand.

Silent chains are not recommended for vertical drive, as it calls for considerable tension to insure engagement of the teeth. For this reason the shafts should be offset and the slack should be on the side making the smaller angle with the horizontal.

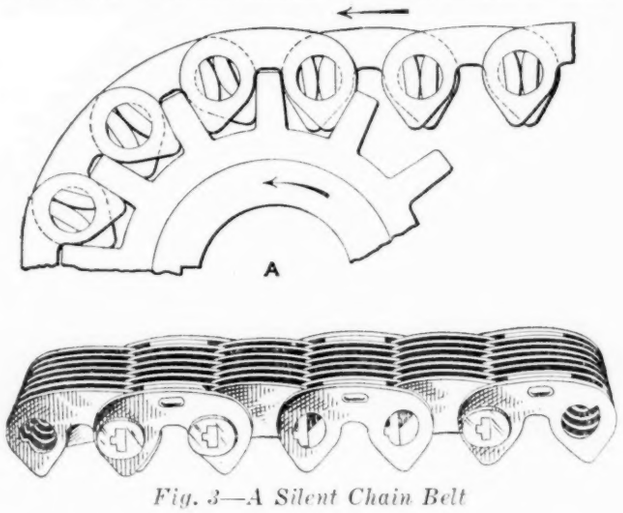
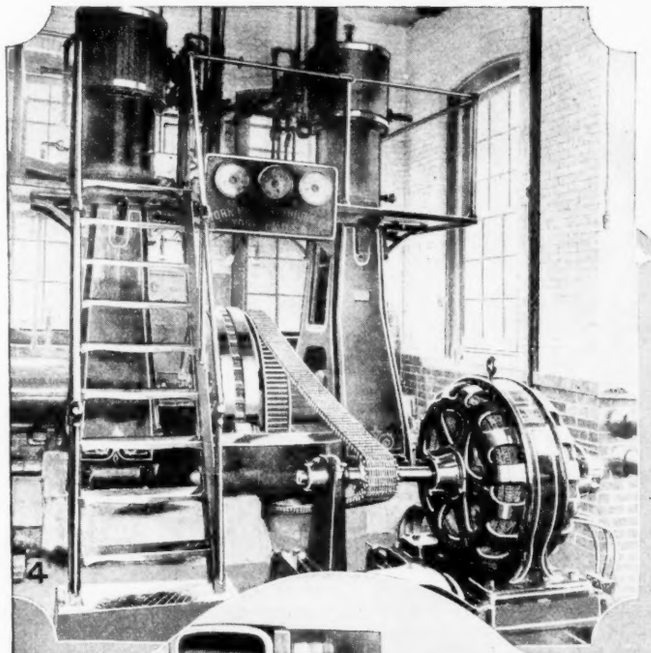
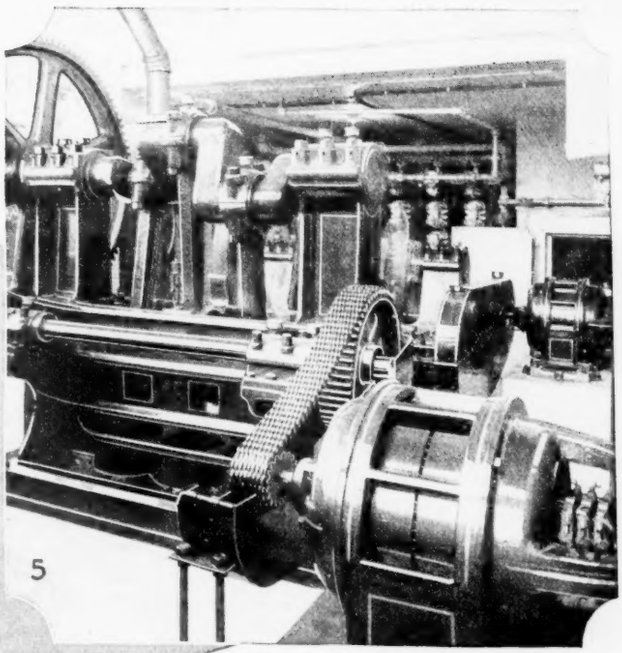


Fig. 3—A Silent Chain Belt

Silent-chain application covers a wide range, from belts of ½ in. to those of several feet in width; horsepowers as high as several thousand may be transmitted. One of the uses most widely encountered is the timing drive on automobile engines. Of greater interest to power engineers is the silent-chain drive used with motor-driven power pumps, compressors, ice machines and fans.





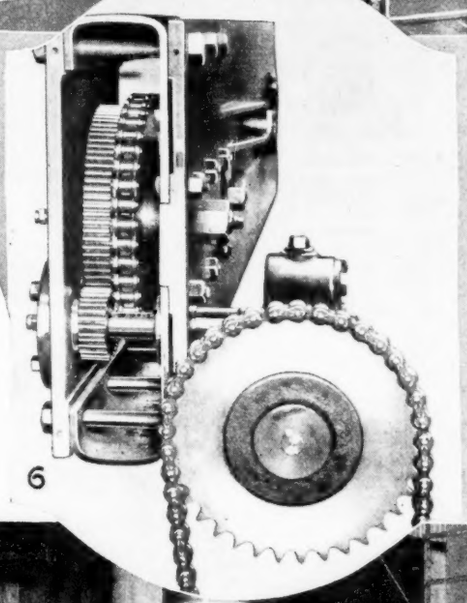


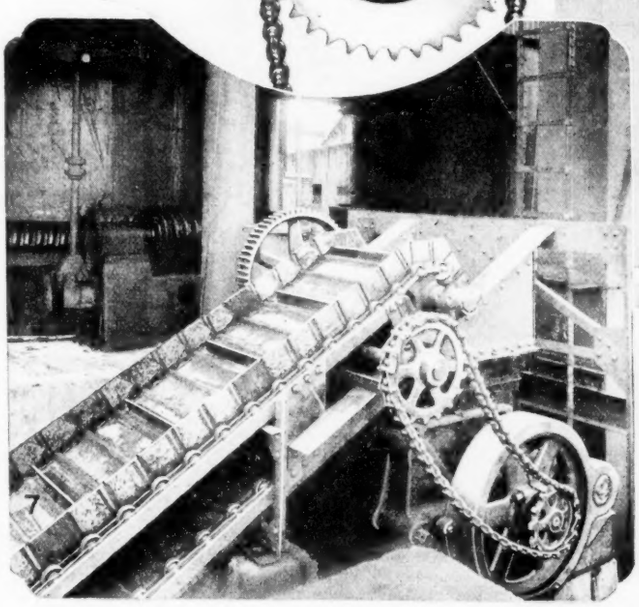
Fig. 4—Air Machine Chain Driven from Motor

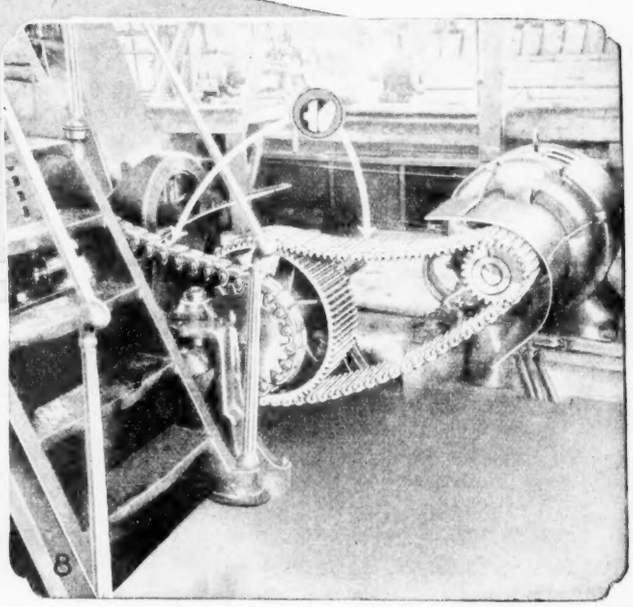
Fig. 5—Chain Drive to Pump

Fig. 6—Roller Chain Drive For Stoker

Fig. 7—Elevator Driven by Sprocket Chain

Fig. 8—Silent Chain Drive of the Machine, Replacing Steam Engine





Effect of Hydraulic Shock Tests on Welded Drum

ANALYSES of tests at plant of A. O. Smith Corp. indicate that about 7,000 repetitions of stress materially reduced strength of plate. Initial stresses in unannealed drum may also have been a factor

ANNOUNCEMENT was made last October of a series of repeated hydraulic shock tests on a welded drum at the works of the A. O. Smith Corp., Milwaukee, with the object of ascertaining the effect of water hammer on penstock lines. A number of representatives of engineering societies and bodies interested witnessed the test, the report of which has now been released.

The drum, which was 45 in. inside diameter, was built up of 2-in. forged steel plates joined by four longitudinal and one circumferential welds. The heads were of 4-in. cast steel welded to the shell. Machine welding was employed in both cases.

About 7,000 repetitions of hydrostatic load were applied over a period of eight hours, at various pressures up to 2,000 lb. per sq.in., during which the unit stress reached 22,500 lb. A load was then slowly applied, and rupture occurred at about 2,700 lb. per sq.in., corresponding to a unit stress in the metal of 32,600 lb. per sq.in. The original ultimate strength of the metal was about 65,000 lb. per sq.in.

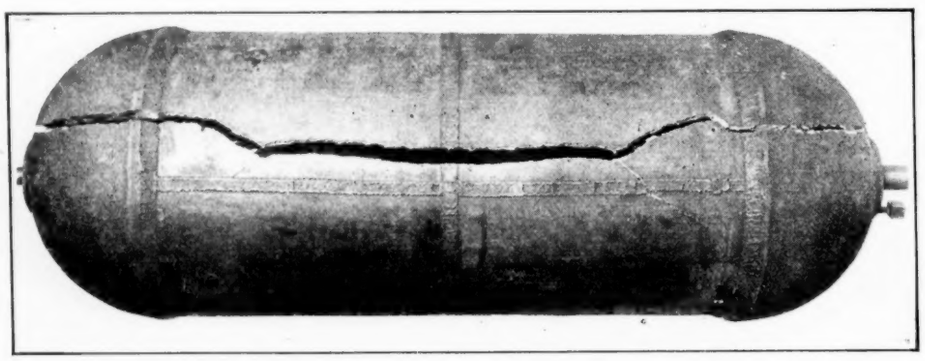


Fig. 1—The crack extended longitudinally through the plate about four inches from the welded seam, and into each head

The main fracture occurred parallel with and about four inches from a longitudinal seam and branched out at each end as shown in Fig. 1. Two circumferential cracks also appeared near the center of the vessel. All the fractures showed a very coarse grain.

Because of the relatively low impressed stress at which failure occurred, it was decided to make further comparative tests on a specimen cut from the original plate and on one from the shell of the drum that had been subjected to the repeated stress. Prof. T. M. Jasper, of the University of Illinois was engaged to make these subsequent tests and to analyze the original test. The results of the subsequent test on the metal are given in the accompanying table.

In analyzing the results of the test, Professor Jasper says in part:

From the standpoint of the impressed stress on the cylinder at failure, it would seem that the cause of this failure was a general fatigue breakdown because of the impressed stress value as compared with the ultimate strength value of the material of which the cylinder was made. From a study of the fracture itself the answer is not so clear because, in general, fatigue fractures are quite different from the one shown in this case. This does not represent fatigue to destruction because the bursting load was a static one and for this reason it was recognized that the fracture, although not one that showed the typical fatigue fracture, might still be the result primarily of fatigue and finally that of static failure in the metal which had been so weakened by the progress of the intercrystalline fatigue that it failed at a relatively low ultimate strength.

The endurance limit of the metal in direct stress in the cylinder before it was subjected to the hydrostatic fatigue test is estimated from actual endurance limit tests in the rotating beam machine to be about 20,600 lb. per sq.in. The actual maximum stress to which this metal was subjected in the hydrostatic fatigue test was somewhere in the neighborhood of 22,500 + 7,900 lb. per sq.in., or 30,400 lb. per sq.in.

The flexure endurance limit of the metal in the cylinder after it was subjected to hydrostatic fatigue was found to be 28,000 lb. per sq.in. The flexure endurance limit of the metal from the same plate but which had not first been subjected to the hydrostatic fatigue test, was found to be 31,000 lb. per sq.in. This shows that the hydrostatic test had overstressed the metal and had thereby reduced the flexural endurance limit 9.7 per cent.

The test specimens were not selected from near the fracture of the cylinder because it was thought that the fracture had extended into the adjacent metal to such an extent that the subsequent tests would have been erratic and no stable conclusions therefore could have been drawn from them. This was assigned as the reason why the static ultimate strength values did not show a larger percentage of decrease from the values given by the virgin metal.

There is no doubt that the fact that the vessel was unannealed resulted in initial stresses of considerable magnitude being present in the material, which stresses were in addition to those impressed by the test. These stresses, calculated from subsequent tests on similarly welded vessels, were undoubtedly in the neighborhood of 8,000 lb. per sq.in. I am convinced that proper normalizing or annealing would have reduced such initial stresses to a negligible quantity.

Tests already performed by the writer show that when initial stresses are present in a metal to the extent of about 35,000 lb. per sq.in., annealing has relieved these stresses to such an extent that their importance is less than the fluctu-

ation found in the ultimate strength values on adjacent metal in a plate. These results were presented in a paper read before the British Association and published in London *Engineering* of Sept. 5, 1924.

RESULTS OF SUBSEQUENT TEST

Static Elastic or Fatigue Property	Metal from the Untested Plate		Metal from the Tested Plate		Per Cent Change in Property of the Metal Due to Hydrostatic Test
	Values	Average	Values	Average	
Brinell hardness No.	112.2 113.6 110.2	112.0	106.2 106.8 106.8 106.8	106.7	—4.7
Impact bending Energy of rupture. Ft.-lb.	26.7 27.8 26.4	27.0	22.2 18.1 22.1 23.5	21.5	—20.4
Elastic limit, lb. per sq.in.	35,000 35,000 34,500	34,800	27,500 29,000 29,000	28,500	—18.1
Yield point, lb. per sq.in.	37,000 36,300 37,800	37,000	28,800 30,900 30,900	30,200	—22.5
Ultimate strength, lb. per sq.in.	65,300 64,000 67,500	65,900	62,500 62,100 62,500	62,200	—5.9
Reduction of area, per cent	50.0 54.4 54.8	54.1	52.1 55.3 52.4	53.3	—0.4
Elongation in 2 in., — per cent	30.5 28.0 30.0	29.8	26.0 31.0 27.5	28.2	—5.4
Modulus of elasticity, lb. per sq. in.	30,500,000		28,400,000		—6.9
Endurance limit	31,000		28,000		—9.7

The above remarks refer to penstocks and vessels which are to be used at ordinary temperatures.

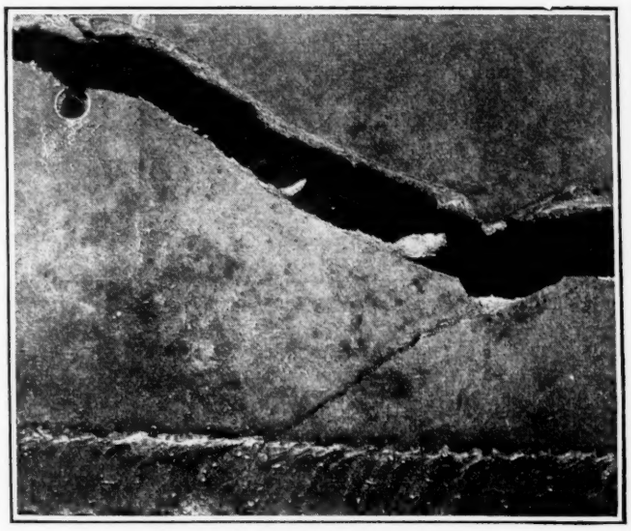


Fig. 2—Close-up view of crack

It is the opinion of the writer, based on experiments now in progress, that annealing is not necessary where vessels are to be used at or above 600 deg. F. for the reason that the very conditions of operation have the effect of annealing the material in such vessels.

Eliminating Boiler Scale by the Agfil Process

By D. A. GARDNER

ONE of the most important duties of the boiler-plant operator is the removal of scale from boiler tubes and heating surfaces or the reduction of scale formation. Boiler incrustation is one of the serious difficulties of power-plant work and is treated in a variety of ways, depending upon such factors as feed-water composition, boiler construction and the cost of the process. The various conditions in different industrial locations—hardly any two problems are closely similar—has made the feld an extensive one for engineers combating scale. Each problem must be analyzed and a remedy prescribed individually.

Scale-removal methods may be classified as mechanical, chemical or electrical. Mechanical methods attack the scale after it has formed in the boiler tubes. Chemical and electrical methods are used primarily to treat the water or the boiler surface to prevent the deposition of scale or to promote the deposition of soft scale rather than hard scale. Naturally, the latter treatments, inasmuch as they fight the scale at its source, are more desirable, but in some cases their success is limited and a combination of one of them with mechanical methods is necessary.

There are many mechanical devices on the market, and all are more or less efficacious, depending upon the hardness and thickness of the scale. Rotating weighted arms, with or without cutters, sometimes followed by wire brushes, make good tube cleaners, and a wide variety of devices have their uses in various types of boilers.

While mechanical methods prove successful in removing heat-resisting deposits, they are applied too late to be successful agents against corrosive action. The removal of solid material may destroy pockets which have been holding corrosive liquids, preventing them from being washed away by the boiler water, but mechanical treatment can seldom do much more than this. There is evidence for believing that the roughening of tubes or shells by pounding or scratching provides surfaces more susceptible to corrosion attack. Bad cases of pitting have been attributed to such roughening of tubes by mechanical cleaners.

TABLE I—ANALYSES OF RAW WATER AND OF SAMPLE DRAWN FROM THE WATER COLUMN

	Raw-Water Sample	Water-Column Sample
Calcium carbonate	22.12	1.60
Free carbon dioxide	1.98	
Magnesium carbonate	0.77	0.63
Calcium sulphate	17.47	30.33
Magnesium sulphate	10.74	1.19
Sodium sulphate	0.98	11.08
Sodium chloride	18.15	132.00
Silica	0.88	0.72
Iron oxide	0.44	Trace
Sodium nitrate	14.13	172.09

TABLE II—ANALYSIS OF SOFT SCALE FROM BOILER HEADER CAPS

	Per Cent of Dry Scale		Per Cent of Dry Scale
SiO_2	5.3	MgO	6.29
Fe_2O_3	2.63	CO_2	23.80
Al_2O_3	1.20	SO_3	19.90
CaO	38.10	Combined H_2O	0.94

The chemical treatment of scale comprises the addition to the water of something to react chemically with the materials already present and to convert them into

substances that will not form scale under the action of heat and steam, or that will form a soft scale or mud instead of a hard, adherent scale.

For the proper application of chemical treatment it is necessary to know the chemical characteristics of the water and of the material dissolved or suspended in it, which usually requires a precise chemical analysis. In some cases activities within the boiler form materials

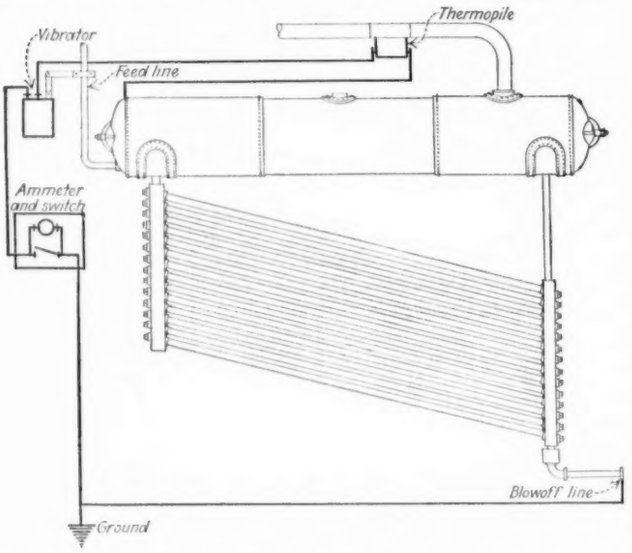


Fig. 1—Diagram of connections shows series circuit through the boiler

not found in the raw water, and these do their share in the formation of scale or the corrosion of the metal, although their existence in the boiler is unknown.

Electrical methods are relatively more successful than either mechanical or chemical treatments, and are something of an innovation in the field. Unfortunately, a theoretical discussion of this method of scale elimination cannot be presented, because as yet no suitable explanation of the action has been developed.

In the past, power-plant experts have warned against the presence of electric currents in boilers, attributing corrosion and pitting to their presence. Now, however, a minute electric current passed over the inside surface of the boiler has been found to prevent the adhesion of scale to the metal and to remove any scale that may have been present before the application of current.

This process was invented in Europe and has been in use there for over three years. More than 300 successful installations are now in operation in power plants, and tests in this country have shown that the method is equally applicable to boiler conditions here. A number of installations have been in service for several months, and indications are that their performance is satisfactorily effective.

The apparatus consists simply of three pieces—a thermopile, a vibrator and an ammeter. Fig. 1 is a diagrammatic sketch showing the method of connecting the outfit to the boiler. The thermopile is fastened to the steam main or to the breeching, so that one face is heated, while the other face is exposed to the relatively cool air of the room. One of the electrical terminals is connected to the upper boiler drum, the other, through a vibrator and an ammeter, to the blowoff pipe. The vibrator consists of an interrupter switch which is carried by a swinging weighted arm. The apparatus is fastened to the feed-water piping or some other vibrating part, and acts as a make-and-break shunt. This produces a direct current which pulsates more or less regularly and seems to be more effective than a continuous direct current. The ammeter serves as an indicator and also provides a means of making adjustments at the time of installation.

When the apparatus is in operation, it seems to prevent scale-forming material adhering to the metal, and causes it to fall to the bottom. The resulting sludge is then eliminated by blowing off the boiler.

The process is very much of a mystery, and all attempts to explain it have been unsuccessful. Electrolysis, electrical repulsion and colloidal action have been suggested as probable solutions, but none has shown satisfactory application, and in fact electrolysis has been practically eliminated because the thermopile at no time generates sufficient current to cause appreciable electrolytic action. Lack of a theoretical basis for the process is not a cause for worry, however, for it has been shown to be practicable despite its unexplainable features.

What occurs in the boiler may be seen from the analyses shown in Table I for samples of raw water before entering the boiler, and of water taken from the

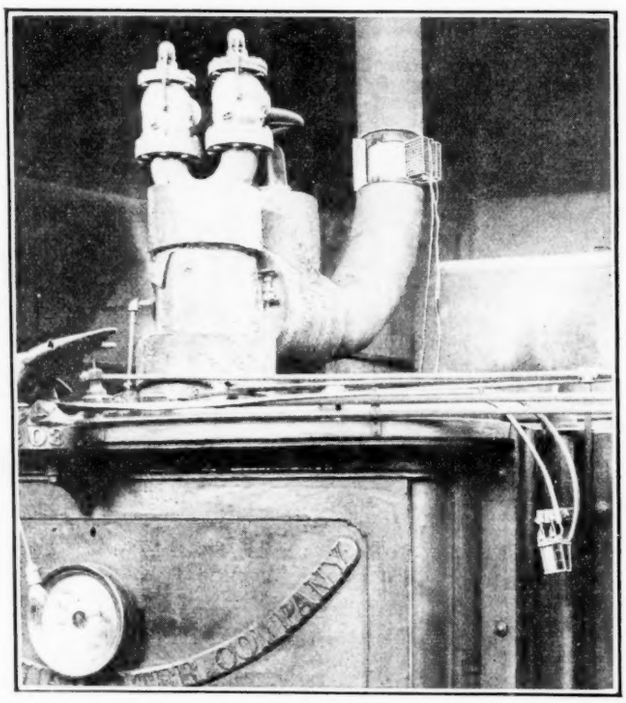


Fig. 2—The pair of thermopiles mounted on the steam pipe, generate the current which is interrupted by the vibrators mounted on the feed pipe at the right

water column of a water-tube boiler at the Fort Pitt Brewing Company at Sharpsburg, Pa., which is equipped with an Agfil installation. No other treatment is used. Table II shows an analysis of a sample of soft scale washed off the header caps.

The advantages of an electrical method such as that described are more or less obvious. No water analysis is necessary, and the apparatus is applicable to all kinds of water and all kinds of boilers. Boiler cleaning is eliminated. Once the device is installed and adjusted, no further attention is required.

Where the Engineer Is Worth His Hire

OPERATING engineers have the spending of thousands of dollars each year in their plants, for labor, fuel and other supplies. These expenditures vary with the size of the plant, but twenty thousand dollars a year is not an uncommon figure, and in the larger plants the costs may run into hundreds of thousands of dollars. The larger the plant the greater the opportunity for waste and also the greater the economies that can be realized. Ten per cent improvement in the cost of operating a plant is a conservative figure. It is not uncommon to learn of plants where the cost of operation has been cut in half by putting a competent man in charge.

With these facts available, the most natural thing to expect would be that when the manager of an industry was employing an engineer to operate his power plant, he would look carefully into the man's ability to keep down costs. Unfortunately, this is not always done; too frequently, the decision is made on a salary basis. If one man is willing to take the job for five hundred dollars less than another, the lower-salaried man in many cases is put to work. No consideration is given to the fact that if the former could save ten per cent in the operation of the plant over the latter and the cost of operating the plant was twenty thousand dollars, a year, the higher-priced man would return a profit of three hundred per cent on the additional salary paid him. The fact that a man asks a high salary is not a guarantee that he is worthy of his hire. It will need some checking up, but the fact remains that an engineer who can get results in a plant has a high financial value, while the fellow who cannot, can easily waste more than he is paid for being around.

Effects of Repeated Stress

ENGINEERS and metallurgists will find opportunity for study and much speculation in the account of the repeated stress tests at the A. O. Smith Company Works, as reported in this issue.

The experiment was undertaken primarily with the object of ascertaining, if possible, the effect of surges in a welded penstock, although for practical test purposes a welded drum was employed.

In attempting to analyze the results, one should bear in mind: First, that failure did not occur along the weld, but rather for the greater distance parallel to it; secondly, in the light of former investigations of repeated stress, the number of repetitions—less than seven thousand—was relatively small. Of course failure did not occur during any of these repetitions of stress, but after a slowly applied pressure up to 2,700 pounds, corresponding to a fiber stress of 32,600 pounds per square inch—about half of what the ultimate strength of the plate should have been. Thus it was evident, as pointed out by Professor Jasper, that the repetitions did materially weaken the metal. This was verified by the subsequent test specimens cut from stressed and unstressed plate.

Considering that the vessel was unannealed, it is likely that initial stresses set up in rolling the plate or by the welding process may have added materially to a reduction in strength. Unfortunately, no test piece was cut from the metal adjacent to the welds such as might have shown the influence of any welding stresses.

It has been further suggested that the welds, acting as ribs, may have tended to make the vessel depart from a true cylindrical form during expansion under stress, thus producing a condition somewhat akin to the familiar lap-seam crack.

Undoubtedly, there were several factors contributing to the failure, the extent to which each shared in the final result being a matter for further study. The report nevertheless forms a valuable contribution to literature on this subject, and the A. O. Smith Company is to be commended for its efforts toward solving the problem.

Steam Turbine Nozzle Tests

ON ANOTHER page of this issue there appears an abstract of a paper presented before the A.S.M.E. Midwest Power Conference, describing work done by the General Electric Company in testing steam-turbine nozzles by the reaction method. While this paper is primarily concerned with describing the method in detail, it presents the two curves (reproduced in this issue) as samples of the results obtained.

Work along this same line has been conducted by the Institution of Mechanical Engineers of Great Britain, and their results have been published from time to time in the British technical press. Apparently, they observed lower values for the velocity coefficient than were obtained by the General Electric workers. It would be both interesting and valuable if those who are thoroughly conversant with this highly technical and somewhat complicated subject would discuss these discrepancies in such a way as to throw light on the matter.

The work done in this country has covered a long period of time, during which many sources of error have been discovered and eliminated, and this, together with the great care exercised in all tests, seems to justify considerable confidence in the accuracy of the results obtained. On the other hand, in the absence of more complete information there is certainly no justification for doubting the accuracy of the work done in Great Britain. Perhaps the types of nozzles tested in the two cases were different, and perhaps other conditions were different.

As in many cases, discrepancies of this sort repre-

sent no real difference of findings, but may be due to a fundamental difference in the nature of the problem. In any event it is to be hoped that someone who is familiar with both investigations will discuss the matter further.

Why Not Give More Information?

MANY power-equipment manufacturers have abandoned the old idea of making their catalogs collections of cut-and-dried sales statements and are giving engineering information on their product. Not infrequently, these publications are to be classed as data or handbooks and find a place in engineers' reference libraries. There is still room for much improvement in the writing of catalogs, since many are still sent out that do not even describe the equipment to which they are supposed to apply. It is not uncommon to find catalogs in which any manufacturer's name and the cut of his product could be substituted in the text without affecting the ideas that the publication was intended to convey. It is evident that such productions are not catalogs in the modern sense, and they are a disappointment to those who read them.

After one has worked through eight or ten pages of a catalog and has not found out how the equipment works that it is supposed to describe, it does not leave one in a pleasant state of mind. Such statements as that the company produces the finest quality apparatus, it has a high efficiency, high overload capacity, high starting torque, the highest-grade workmanship is used, etc., have little meaning unless they are backed up with some actual information to substantiate the claims. Characteristic curves and data tables are much more impressive than any bald statement regarding the equipment and are much more likely to be studied. If the characteristics of the equipment are to be discussed, let it be around something real and tangible that can be compared with similar devices produced by someone else.

Above all, a catalog should show how the equipment is constructed. If there are any special features of construction, the engineering reasons for adopting them should be given, and if the method of operation of the equipment is not readily available in technical books, it should also be explained. It may be argued that space in many cases will not allow such treatment, but it is not uncommon to find expensive catalogs of twenty or more pages filled with generalities, when at least part of the space could have been devoted to specific facts that would have been useful to those looking for information on the equipment. One of the best ways to keep catalogs out of the waste basket and get them filed for future reference is to make them worth reading.

The Smoke Peril

SMOKE is a nuisance to everybody. To the operating engineer it is more than that—a peril to his job. For the cause of a nuisance is certain to incur public disapproval, and disapproval is likely to be followed by unpleasant action.

The reality of this danger is made evident by a study of conditions existing in Eastern cities as a result of the coal strike. New York, to take an important example, is normally an anthracite-burning city. (Her central stations—it is true—generally use bituminous coal, but with combustion so well regulated as to produce relatively little smoke.) With anthracite burned almost exclusively in industrial plants, office buildings and apartment houses, the air is normally as clear as that of an up-state village.

But now that the pre-strike stocks of anthracite have practically vanished, a marked change has come over the city. Black smoke is belching from a thousand chimneys, giving the citizens an unpleasant taste of London murk and Pittsburgh fog. Only the laundrymen are happy. Everybody else is kicking. Groping around to find a solution, the authorities have hauled several otherwise law-abiding engineers into court and imposed substantial fines for violation of the smoke ordinances.

While it is mechanically possible, granted suitable boiler settings and skillful operation, to burn almost any fuel without much smoke, it is only to be expected that furnaces designed to burn anthracite and handled by men brought up on that fuel should smoke badly with bituminous coal. Inspectors and courts may improve matters a little by harassing the engineers, but all their efforts can hardly make New York a spotless town this winter. Incidentally, New York might take a leaf from the experience of some Western cities and put co-operation ahead of punishment. The department in charge of smoke prevention should be prepared to send out practical combustion experts to demonstrate the possibility of smokeless operation of any particular installation before proceeding to arrest the engineer for making smoke.

The situation demands the immediate attention of operating engineers. Continuation of the smoke nuisance will undoubtedly provide good ammunition against the operation of isolated plants, particularly in the summer when there is no heating load to make boiler operation unavoidable. To protect their jobs against possible adverse public sentiment, engineers should give the closest attention to the smoke question, considering particularly the matter of modernizing boiler settings and operating methods so as to permit burning soft coal with no more smoke than is produced by the better-managed central stations.

"Boiler and Turbine Room Instruments," a serial report just issued by the N.E.L.A. Prime Movers Committee, should help dispel some common illusions about instruments. Temperature readings, in particular, are often misleading. Not only must great care be taken in the selection of reliable thermometers and electric temperature-measuring instruments, but considerable judgment must be used in locating the thermometer element and interpreting the results obtained. The possible errors due to improper setting of mercury bulbs or thermocouples, when measuring temperatures of turbine exhaust, flue gas, circulating water, etc., are surprising. It is well known that considerable differences of temperature exist at various points in the cross-section of a moving fluid, but not all engineers appreciate the difficulty of getting the true temperature even at a given point.

One of the effects of the present anthracite strike is added stimulus to the development work now going on with low-temperature carbonization processes. If the operators and miners keep up the struggle much longer, the use of substitutes may force anthracite next season into a buyer's market.

Practical Ideas From Practical Men

Power is pleased to announce the awards of the judges for the first and second prize contributions received during December for this department in accordance with the terms of the contest.

The first prize of $25 goes to E. Andrews, of Manchester, England, for his article on "How to Reduce the Percentage of Scrap in the Power Plant by Autogenous Welding," in the Feb. 2 issue.

The second prize of $15 goes to Andrew F. Sheehan, of Brightwood, Mass., for his article on "How the Over-all Efficiency of the Steam Plant Was Increased," in the Feb. 2 issue.

The judges were: (Chairman) Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City; Norman M. King, chief engineer, Singer Bldg., New York City, and D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City.

Getting Water Into the Engine with a Barometric Condenser

In all the descriptions of the barometric condenser and its operation, that I have read, the one outstanding claim for this type of condenser was that it is impossible to get water into the cylinder of the engine, yet water can and has wrecked an engine that was equipped with a barometric condenser. The defect is not in the design or construction of this type of condenser, but in the installation. Like all other equipment it must be installed right or someone pays dearly for mistakes.

The theory of the barometric condenser is that it is impossible to lift a column of water to a greater height than 34 ft. by vacuum, and so long as the surface of the hotwell is 34 ft. below the condenser head, no water can go over into the engine exhaust pipe. This is true provided the end of the discharge pipe is covered with water. If the cubical contents of the hotwell above the end of the discharge pipe are not greater than the cubical contents of the discharge pipe, trouble may result.

The reason is that as soon as the steam is shut off, water stops flowing out of the bottom of the discharge pipe, owing to the loss of momentum imparted to it by the steam. Immediately after the loss of momentum the direction of flow in the discharge pipe is reversed owing to the atmospheric pressure on the surface of the water in the hotwell. Should there be insufficient water above the end of the discharge pipe to fill it to a height of nearly 34 ft. (depending upon the barometric reading), the rest of the discharge pipe will be filled with air. The first conclusion is that the air entering the pipe will lower the vacuum and reduce the height to which the water would rise, which would be true provided the air was on the top of the entering column of water instead of at the bottom. As a result of the air being at the bottom of the column of water, it will force its way to the top, expanding and increasing in volume, also increasing its own velocity and that of the water in the pipe with it. Instead of stopping at a height of 34 ft., the water will, owing to its velocity, continue on through the condenser head and then to the engine.

Most engineers know the theory of pumping water by air lifts and how the air induced in the discharge pipe at the bottom of the well, will, by its expanding, because of the reduction of pressure as the air nears the surface, increase the original velocity of the water entering the pipe at the bottom of the well, several times. A good description of this by Frank Richards appeared in the April 17, 1923, issue of *Power*.

A good and simple illustration of this phenomenon can be had by taking a bottle and nearly filling it with water. Place the thumb over the mouth of the bottle, invert it and remove the thumb, holding the bottle upside down. The inrushing air will be seen to carry the water up against the bottom of the bottle even when nearly empty. If the mouth of the bottle is immersed in a pan of water before removing the thumb, no motion will be observed within the bottle, except a slight lowering of the water.

It is probably true that not many engines equipped with this type of condenser have been damaged by water. I believe that, on account of the claim of impossibility of water rising to a greater height than 34 ft. in a vacuum, a warning should be made about having the size of the hotwell so that the volume of water above the end of the discharge pipe will always be more than ample to fill the pipe to a height of 34 ft. and still keep the end under water.

The majority of engineers today read all the technical magazines they can to get the facts on faults that show up in different types of machinery and why. Thus a man staying in one plant may be as well posted as those who have traveled the country over, getting their experience first hand. A lot of men have false pride and refuse to admit that they have any operating difficulties, but this is a mistake. They owe it to themselves and every other engineer to pass them along.

Rockland, Mass. BURTON W. WHEELER.

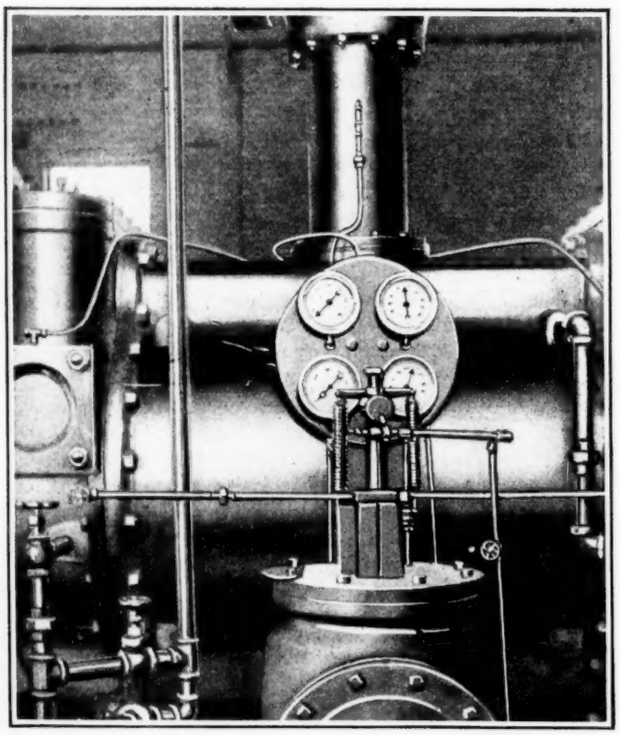
Convenient Location of Gages

When employed as an erecting engineer, one thing that was very noticeable to me in going into many engine rooms, was to see gages in all manner of places with no regard for convenience for being seen or accessibility.

When I took charge of the plant I am now operating, this condition prevailed. The most noticeable instance was four gages connected to a large air compressor, which one might say were scattered all about. The

intercooler gage was tapped into the intercooler high up from the floor, and one had to bend one's head back and look up to see it. The vacuum gage for the suction line was on the suction line, partly hidden by the regulator valve and pipe. The air-line pressure gage was mounted on a wood block nailed to the brick wall back of the compressor, and the water-pressure gage was also located on the wall in a similar way, but 25 ft. farther along. So in order to note the reading of all the gages, one had to look up to see one, step to one side and peek around the regulator valve to see another and then take a trip along the wall to see the other two.

Also, there were three recording instruments, a flow meter, high-pressure tank gage and a clock, all at different points. One recording instrument for air pressure was also mounted on the wall at still another point



All compressor gages are mounted on one board in a convenient place

from the two gages mentioned. The other two recording instruments, one a direct-current voltmeter and the other an alternating-current voltmeter, were at opposite ends of the engine room, while the clock was mounted on the switchboard shadowed by two other instruments in such a way that it could be seen only while standing close in front of it.

One of the first steps toward improvement was to centralize these gages and instruments. The photograph shows how the four gages for the large air compressor were brought to one location by making the round steel plate panel and mounting it on an upright piece of steel plate and bolted to a flange on the suction line of the compressor. The two top gages are the intercooler and air-line pressure gages. The bottom two are the vacuum and water-pressure gages. These can all be observed at one glance and can be seen at a much longer range than when they were mounted on the wall.

The flow meter, recording pressure gage, high-pressure tank gage and clock were all mounted on another panel at a central point in the engine room, where they could be seen from each direction. The two recording voltmeters were moved to a convenient point on the switchboard, where they could be readily observed over a wide range.

Having the instruments conveniently located makes the operating of a power plant much more comfortable, and they will be much more accurately read.

Sewickley, Pa. L. M. JOHNSON.

Leaky Air Compressor Valves Increase Air Temperature

In looking over back numbers of *Power* for certain information, I noticed many letters on leaky air-compressor discharge valves, the evident purpose of the writers being to account for explosions and fires in compressed-air systems.

We have a number of air compressors in our plant and naturally we occasionally have leaky discharge valves. Some of the compressors have both discharge and inlet valves of the automatic poppet design, and some have mechanically operated inlet valves, with poppet discharge valves. In some cases both the inlet and discharge valves are inclosed in a chest, and consequently we cannot feel the valves when the machine is in operation. In other cases the covers or bonnets of the discharge valves are exposed and can be felt when the machine is running, and any difference in temperature can be detected. If the temperature rises high enough, as it sometimes does, any oil on the outside of the bonnet will smoke.

Our attention was first called to the rise in temperature when the output of a compressor suddenly fell off, and in searching for the cause we noticed the oil smoking on one of the valve bonnets. Examining the valve, we found it broken, permitting the air to leak back into the cylinder. It was obvious that the rise in temperature was due to the friction of the air leaking past the valve, because if the temperature of the air in the discharge line had been the same as that of the valve the smoking would not have been confined to the one bonnet and valve. It would also seem reasonable to suppose that it would be possible for the temperature to rise to the ignition point of the oil and carbon which is in contact with the valve, and a fire, once started, would travel anywhere through the system.

One writer remarks that the temperature rise theory will not go down with him, but it does here, because when the output of a machine drops suddenly, the first thing we do is to feel the valve bonnets for a difference of temperature and we locate the broken valve without fail.

As to the theory for the rise in the temperature of the air, it would seem that as the only heat in the air is that due to compression, in leaking past the valve into the cylinder the air would expand and give up that heat. Also, as the cooling water is continually removing heat from the cylinder wall, which heat is absorbed from the compressed air, one would naturally conclude that the temperature should fall below normal. What can be the difference between this process and that going on in an intercooler? R. MCLAREN.

Toronto, Ont., Canada.

Comments from Readers

Recooling Oil-Engine Jacket Water

In an article on re-cooling oil-engine jacket water in the Jan. 12 issue, the author points out the dangers of recooling jacket water by means of cooling towers through concentration of scale-forming solids.

If the water supply is so hard as to make it dangerous in this manner, a heat exchanger might be installed so that the cooling water circulates through a closed system and is cooled by an outside supply of water circulating through a cooling tower. In this manner the water in contact with the engine can be of any purity desired, while the advantages of a cooling tower and low cost of makeup water are obtained. Comparatively little scale will form in the heat exchanger, as the temperatures therein are comparatively low and such scale as does form, can easily be removed. The additional cost of the exchanger is small as compared to the usual cost of purchased water. GEORGE GIBSON.

New York City.

Charging Refrigerating System with Ammonia

In the questions and answers department of the Jan. 5 issue the question is asked, "What is the best procedure to follow in putting the initial charge of ammonia into a refrigerating system."

The answer as given is correct so far as it goes, but it fails to take in one important part of the question, namely, "initial charge."

In such a case it is of course first necessary to exhaust the air from the system. To do this, open the main stop valve on the suction line at the compressor and close the main stop valve on the discharge. Then open the cylinder bleeder valve on the discharge connection, if the compressor is a double-acting one, or loosen up the flange connection between the compressor and discharge valve and wedge it open so that the air may be discharged to the atmosphere. Be sure that all valves on the system are open both on the coils and condenser. Turn plenty of water on the jacket of the compressor and start the machine, running it slowly if possible.

The time required will of course depend upon the size of the plant, but if all is as it should be, the high- and low-side gages will soon begin to show a vacuum reading. Continue pumping until the gages show as high a vacuum as possible, shutting down occasionally if necessary to keep the compressor from overheating. When this has been done it is a good plan to let the system stand for several hours or over night, noting whether the pressure gages rise in the meantime; if they do, one or more leaks exist and should be found before the charge is put in. If all is found to be O.K., a drum of ammonia may then be connected to the charging connection and the valves opened, not forgetting in the meantime to close the opening to the atmosphere and then open the discharge valve on the compressor.

Bellingham, Wash. OSCAR CRITCHLOW.

Convenient Engineering Units

I have been heartily in sympathy with the policy of *Power*, in eliminating in so far as possible the use of the unit "boiler horsepower" and of percentage "normal" rating. I have been glad to see that a more rational designation of boiler size and rate of output is gaining ground, important factors in this change being the existing great variation in form of boiler and related heating surface, and the high outputs obtained. It is usual practice in our engineering department to specify boilers in square feet, approximate rate of evaporation in pounds of steam per square foot per hour, and hourly boiler output in pounds of steam. For accurate designation of output it is, of course, necessary to give feed temperature and steam pressure and temperature. In other cases thousands of B.t.u. (M B.t.u.) and M B.t.u. per hour are used respectively for output and capacity. These latter units are the most fundamental, but for approximate work pounds per square foot rating and pounds per hour for total output are often sufficiently accurate and are easily translatable into turbine output.

I have been interested in the discussion going on in the columns of your journal as to units of evaporation and capacity. A foreword in the issue of June 2, 1925, and a further discussion in the issue of July 28 (p. 147) brought up the matter of new units and quoted a number of suggestions made. It seems unnecessary, however, to provide a new name for the unit equivalent to 1,000 B.t.u., as the term "M B.t.u." is convenient to use, verbally or in writing, and accurately designates the value in mind. For a similar unit of capacity "M B.t.u. per hr." is suggested. It may be that in the future some briefer designation for this rate of output will be adopted, comparable to the use of kilowatt in electrical parlance, but for the present this does not appear necessary.

Personally, I should like to see the metric system gradually introduced in the entire engineering field, and feel that the change, if made through a period of years, would introduce less awkwardness and expense than is ordinarily anticipated by the conservatives.

Engineers and others waste quantities of time in the aggregate, wrestling with our complicated English measures. One of the specially undesirable units is the gallon, which is conveniently translatable into the fundamental units of neither weight nor volume, but is yet firmly established in the rating of pumps and in general in water supply. For this reason it is the custom of our engineering department, in the case of power station pumps, to use pounds per hour for output, and of large pumps for other purposes cubic feet per second. Similarly we usually express metal thickness in linear measure, in some cases with a gage number in parenthesis, and gravity of oil as a decimal fraction, with degrees Baumé in parenthesis if thought desirable.

For the present, so long as the English system is in use in this country, it is believed wise to use the fundamental units wherever practicable: that is, the foot

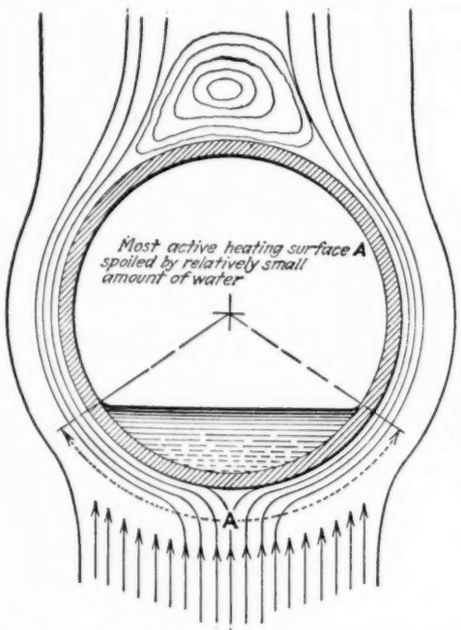
nd the pound, and some convenient unit of time; while the second is the time unit of the foot-pound-second system, it is not usually convenient for power-house work, because ratings and outputs, steam consumptions and other values are almost always referred to the hour.

LOUIS ELLIOTT, Steam Plant Engineer,
New York City. Electric Bond & Share Co.

Why Did the Steam Fail to Heat?

Referring to the letter of A. F. Sheehan in the Nov. 17, 1925, issue, in which he tells us that live steam failed to give sufficient heat while satisfactory results were obtained with exhaust steam, it is my opinion that the pulsations of the exhaust steam kept the condensate removed from the tubes, whereas the slow-traveling low-pressure live steam did not.

This is easily understood from the following explanation: (1) A heater is at the same time a condenser, and keeping the condensate removed is most essential



Illustrates how active heating surface is wasted owing to water accumulating in the bottom of the tubes or pipes

for satisfactory operation. Most heaters have considerable restriction at the outlet such as a partly closed valve, a number of elbows and tees, a sluggish trap and practically no steam pressure. It is possible to have 8 lb. steam pressure ahead of the inlet valve and 2 to 5 in. vacuum in the heater. (2) Exhaust steam usually travels at fairly high velocity, and as it enters the heater, it generally contains considerable water. This pulsating, heavy water-steam mixture, blowing through the heater without any obstruction or throttled outlet, ejects the accumulated water easily. (3) When live steam is used, most engineers will throttle the inlet and outlet valves in order to save steam even though a good trap is used. That means that the steam will travel slowly in the heating tubes and pass over the water without driving it out. And as the condensate accumulates in the lower part of the tube, the most effective heating surface is wasted, as can be seen from the sketch.

It has been my experience that a heating element under 100 lb. pressure, when placed horizontally, may fail, whereas a heating element under 5 to 10 lb. pressure, placed in an inclined position, will give good results.

At least 5 lb. pressure is needed to operate the average low-pressure trap. With lower steam pressures a vacuum pump is needed to draw off the water.

East Pittsburgh, Pa. G. VAN DEN BERG.

Coal a Public Utility

I have been thinking over the Foreword in the Dec. 8, 1925, issue entitled "Coal a Public Utility," and feel that it is unfortunate that there are a number of men like the editor around New York whose command of publicity is out of proportion to their apparent knowledge of the coal situation.

In my opinion, the attitude of the Administration in refusing to meddle in the strike is one of the most encouraging features of the present situation, for it is chiefly in hopes of a political aspect being put on the strike situation that the miners have held out and refused to negotiate except on the basis of the acceptance of most of their principal demands.

I am closely in touch with the buying of about 2,000 tons per month of semi-bituminous coal from a region where a great deal of coal is being sent for domestic fuel and, although we have no permanent connections and are buying on the spot market, we have not yet paid more than $2.25 per net ton f.o.b. mines for run-of-mine coal as compared with a minimum price during the slackest fall period of $1.85 and an average price for the year prior to Oct. 1 of about $2. The freight to the New York piers is $2.73 per gross ton and lighterage to New York points is probably $0.30 to $0.40 so that, as your local retail dealers can probably command prices comparable to this, you can see that the extortionate prices are largely due to the local retail dealers. The statements of Mr. Berry, former fuel administrator and now I believe controller-elect for New York City, confirm this. So why not go after this part of the trouble at the source? Fully 80 per cent of the domestic fuel of the United States is bituminous coal, and I agree, having used it, that it is not as convenient as anthracite, but I would infinitely prefer if necessary to worry along on it for a year or two rather than see the government working into the coal business.

The coal-mining business has been repeatedly investigated and any quantity of facts accumulated, the last being the Coal Commission of 1922-23 whose recommendations the President has been trying to get Congress to put in force ever since, but like many problems in human relations the experts cannot agree on the interpretation of the facts and on how to bring the two parties to the disagreement, to be satisfied with their conclusions.

I cannot at all agree with the statement that the mining and distribution of coal is any more a public utility than our food supply. All the services by which we live, the supply of clothing, food and fuel are in that way charged with public interest, but the only present danger, and one which you are, consciously or not, increasing the likelihood of—a monopoly in the coal industry—is a labor monopoly by the miners' union, and it is only because the public has, wisely or not, granted a controlled monopoly in the fields of

transportation, etc., that they are entitled to interfere in their operations. The whole theory of governmental relation to business has been hands off as long as free competition has been maintained, and in no business has competition had a freer hand in the last few years than in coal. If, in spite of the advice of public officials and practically all the experts on the subject, you insist that anthracite is a necessity of life and no substitutes are possible, your attitude is logical, but not otherwise.

New Haven, Conn. H. D. FISHER.

Connecting Transformer Banks in Parallel

I was interested in the article by M. A. Anderson in the Dec. 1, 1925, issue, on phasing-out transformers, as not long ago I had a similar job to do. Two alternating-current generators can be phased out by an induction motor, but the fact that the two machines have the same phase rotation has nothing to do with their being in synchronism. The latter is a condition that must be determined by a synchronoscope, lamps or a voltmeter. Connecting similar leads on two banks of transformers together and assuming that they are in the right relation for parallel operation is a dangerous practice, as Mr. Anderson learned by experience.

Before single-phase transformers are connected in delta banks, or two or more banks are connected in parallel, they should be tested for correct polarity. If no other means are available, a piece of small fuse wire, about 5-ampere size, may be used. After a bank of transformers is connected in delta, and before closing the primary switch, a piece of fuse wire should be connected into the secondary side as in Fig. 1. If the polarity of all the transformers is the same and they are connected correctly, the fuse should not blow. Any irregularity that will cause a short-circuit between the transformers will cause the fuse to blow.

We had six transformers in operation, all made by the same company. Three of these were rated at 7½

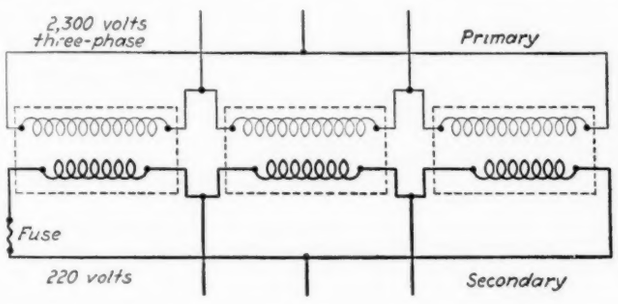


Fig. 1—Fuse wire connected in secondary to test the connections of transformer bank

kva. each and three at 10 kva. each. It became necessary to install three 25-kva. transformers to operate as a bank at certain times and to work in parallel with the other banks at other periods. The new transformers were first connected in delta with a piece of 5-ampere fuse wire in the secondary circuit, as indicated in Fig. 1, and the connections found to be correct, since the fuse wire did not blow when the primary switch was closed. This bank was then connected temporarily in parallel with one of the other banks, as in Fig. 2, and fuse wire connected into the secondary circuit as shown. The fuses did not blow when the primary switch was closed, therefore it was assumed that the connections were correct and they were made permanent after removing the fuse wire. This method takes a little

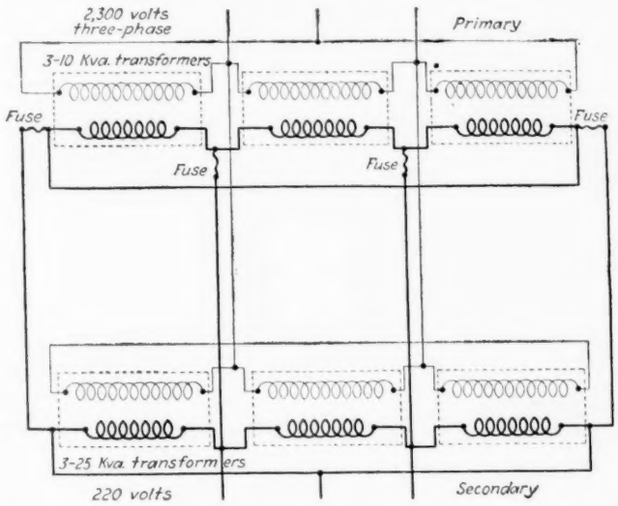


Fig. 2—Fuse wire connected in secondaries to test the connections of two transformer banks

time, but it is safe and fuse wire is cheap. In making these tests there is no load on the transformers and only the primary switch is closed. PIERRE T. WILLIT.

Paulding, Ohio.

The Hydrostatic Test for Boilers

I read the article by George M. Jacobs in the Jan. 19 issue, concerning the hydrostatic test for boilers, and I agree to some extent with him. It is my opinion that to inspect any boiler thoroughly, both tests should be used. I have condemned several boilers that would have withstood a rigid hydrostatic test, but under the hammer and experienced eye, as Mr. Jones put it, they were of no good whatever.

In one instance, I was sent out to inspect two 4,590-sq.ft. water-tube boilers for a manufacturer who was about to buy them for installation in his plant, and from all outward appearances they looked to be in perfect condition. However, upon examination of the water legs with hammer and eye, I found I could drive the hammer through them in several places, as they were only ⅛ to 7/64 in. thick from pitting, although they looked good with 300 lb. of cold water on them. As to the 38-year old boilers Mr. Jacobs referred to, he does not give the diameter or how they were stayed, but I dare say they could have easily been made to withstand a rigid hydrostatic test.

I have removed old boilers and installed new ones in ships out of New Orleans that marine inspectors had allowed to operate at 200 lb. when, as a matter of fact, they were not safe at 50 lb. As to marine inspection, statistics show more boiler ruptures and explosions in marine service in proportion to the number of units in service, than on land.

Believing in safety first, last and all the time, give me both tests and make them rigid.

St. Charles, Mo. JOS. D. DAVY.

A new slant on things observed in and out of the power plant

What Happens and Why?

Fractional Powers

TO THE average engineer fractional powers are a nuisance. Such an expression as $6.2^{0.47}$ bothers him. Yet it so happens that certain problems relating to air compressors, steam engines, etc., involve computations of this sort.

An example is the following formula giving the theoretical horsepower required to compress and deliver 100 cu.ft. of free air per minute with a single-stage compressor.

$$1.5\,P_1(R^{0.29}-1)$$

where P_1 = pressure of free air in lb. per sq.in., absolute, and R = ratio of final pressure to initial (both absolute).

Taking a specific example, suppose that the initial pressure is 14.7 lb. absolute and the final 100 lb. gage, or 114.7 absolute. Then $R = 114.7 \div 14.7 = 7.8$ and the formula becomes

$$\text{Horsepower} = 1.5 \times 14.7(7.8^{0.29}-1).$$

The only difficulty in simplifying this lies in the fractional power. Even this is easy with the accompanying diagram. Following directions given on the diagram, it is seen that

$$7.8^{0.29} = 1.81.$$

Then

$$\text{horsepower} = 1.5 \times 14.7\,(1.81 - 1)$$
$$= 1.5 \times 14.7 \times 0.81 = 17.9 \text{ hp.}$$

This diagram gives a convenient method of extracting square root, cube root, etc.

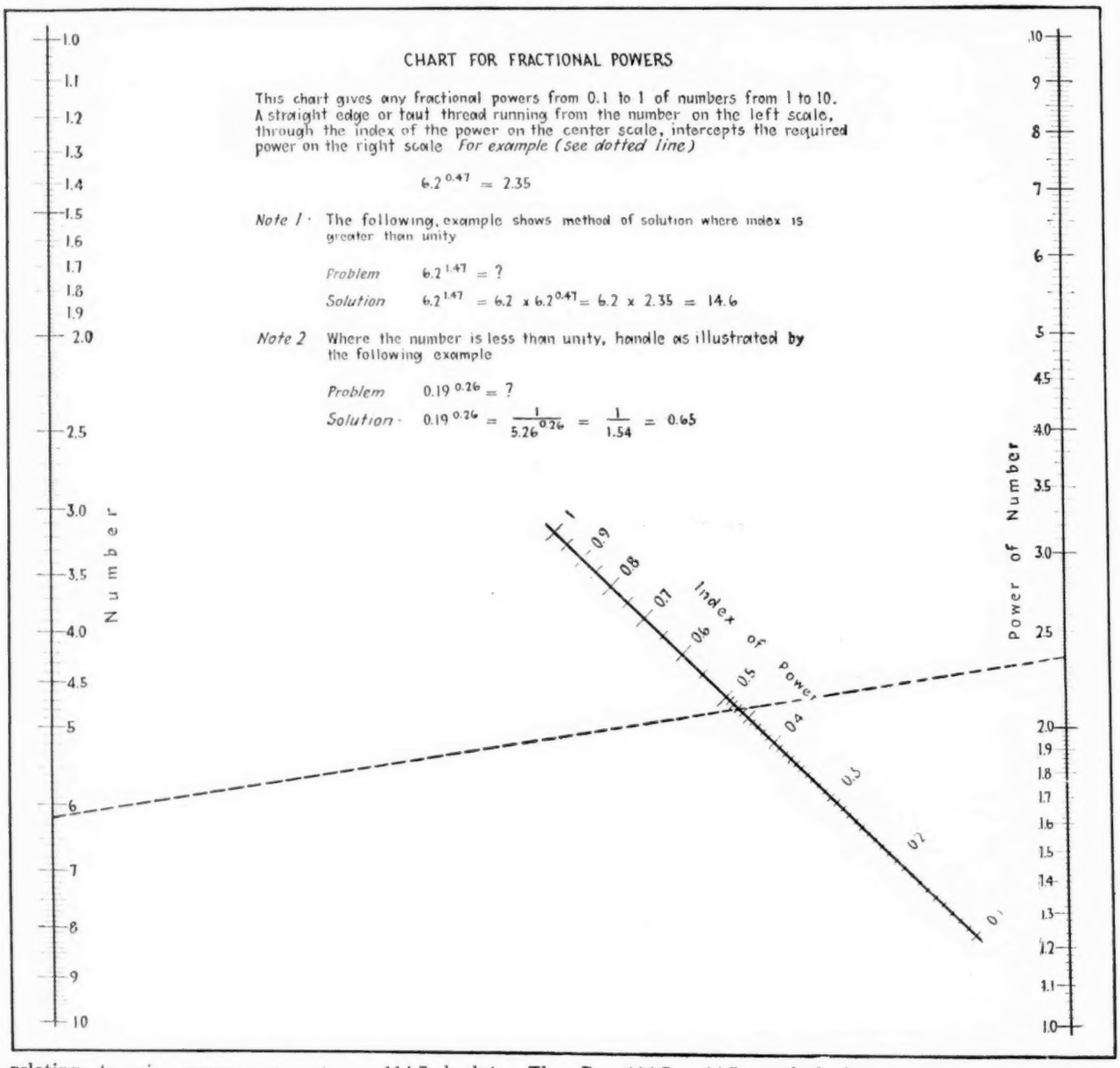


CHART FOR FRACTIONAL POWERS
This chart gives any fractional powers from 0.1 to 1 of numbers from 1 to 10. A straight edge or taut thread running from the number on the left scale, through the index of the power on the center scale, intercepts the required power on the right scale For example (see dotted line)
6.2 0.47 = 2.35
Note 1 · The following example shows method of solution where index is greater than unity
Problem 6.2 1.47 = ?
Solution 6.2 1.47 = 6.2 x 6.2 0.47 = 6.2 x 2.35 = 14.6
Note 2 Where the number is less than unity, handle as illustrated by the following example
Problem 0.19 0.26 = ?
Solution · 0.19 0.26 = 1/5.26 0.26 = 1/1.54 = 0.65
Number
Index of Power
Power of Number

Notes on the diagram show how to use it for cases where the index is greater than unity or the number is less than unity. Where the number is greater than 10, the procedure may be as illustrated by the following example:

$$14.4^{0.35} = (10 \times 1.44)^{0.35} = 10^{0.35} \times 1.44^{0.35} = 2.24 \times 1.13 = 2.53$$

A Machine for Testing Steam-Turbine Nozzles by the Reaction Method*

BY G. B. WARREN† AND J. H. KEENAN†

SOME years ago the General Electric Company undertook the development of apparatus for finding the relative efficiencies of various types of nozzles and the absolute values of the losses in those nozzles. Investigations made continuously since that time have supplied information that has been utilized in the design of nozzles and has provided data that have been valuable in the analysis of results obtained from tests of the turbine as a whole.

A part of this development followed the type of investigation outlined by H. Loring Wirt,[1] in which nozzles were tested with air, and another part took the form of the development and operation of a reaction-nozzle testing machine. These two investigations were carried on together; the reaction-nozzle tests giving the absolute values of the nozzle efficiency, while the air test permitted an analysis of the component losses and the investigation of latter stage nozzles which were too large for the reaction machine.

Direct comparative turbine tests made on nozzles tested by the air and reaction methods have borne out the conclusions obtained from the nozzle tests, but since so many variables are involved when moving buckets are used, definite comparisons are somewhat complicated, and a discussion of these tests need not be given at this time.

The nozzle-testing apparatus here described is simply a device for measuring the flow through a sample nozzle, the steam conditions before and after it, and the reaction of the issuing jet.

The nozzle-testing machine and its auxiliary apparatus are shown in Figs. 1 and 2. The nozzle group is bolted to the bottom flange of a vertical pipe so that the nozzle discharges horizontally. This vertical pipe is hung from a hollow horizontal shaft, supported at each end on ball bearings. The moment about the bearing axis of the reaction force at the nozzle is transmitted through a horizontal arm on the shaft to sensitive platform scales. Steam is admitted at one end of the enveloping cylinder, enters the shaft through radial holes, and flows through the vertical pipe, through the nozzle, into the exhaust chamber, thence to a surface condenser. From the hotwell of the condenser the condensate line leads through a pump to the weighing tanks, where a quick-closing valve operated by a precision clock automatically times the weighing operation.

In order that the friction in the reaction element will not introduce appreciable systematic errors the reaction scales are mounted on cams which allow moving the scales up and down, which in turn moves the element back and forth through one-half a degree. When moved in one direction the friction acts *with* the reaction, when moved in the opposite direction it acts *against* the reaction. This method is used to obtain tare as well as gross reaction values, and the difference between the means of the two sets is practically free from friction effects.

It is extremely important to insure that all the steam that passes through the nozzle reaches the condenser and that no additional steam or water enters there without its quantity being known. The prevention of leakage into or out of the system is comparatively simple everywhere except in the condenser and at the swinging shaft.

Along the length of the shaft at the inlet end of the machine steam must be prevented from leaking into the exhaust chamber. Two lengths of labyrinth packing (0.010 to 0.015 in. radial clearance) are provided on this section of the shaft. From the space between them sufficient steam is drawn off to an auxiliary condenser to maintain the static pressure in that space equal to the pressure in the exhaust chamber within a quarter of an inch of water. Special tests have shown that with the length of packing and the close clearances used, the device is so effective that a pressure unbalance of several inches of water could exist without introducing appreciable error into the flow measurements.

The packing along the other end of the shaft is balanced in much the same way except that here the pressure in the packing is kept slightly below atmospheric pressure so as to have a gentle flow of air inward. Since the steam drawn from the packing in this case has come from the exhaust chamber, it is necessary to lead it to the main condenser, where it is mixed with the rest of the nozzle flow.

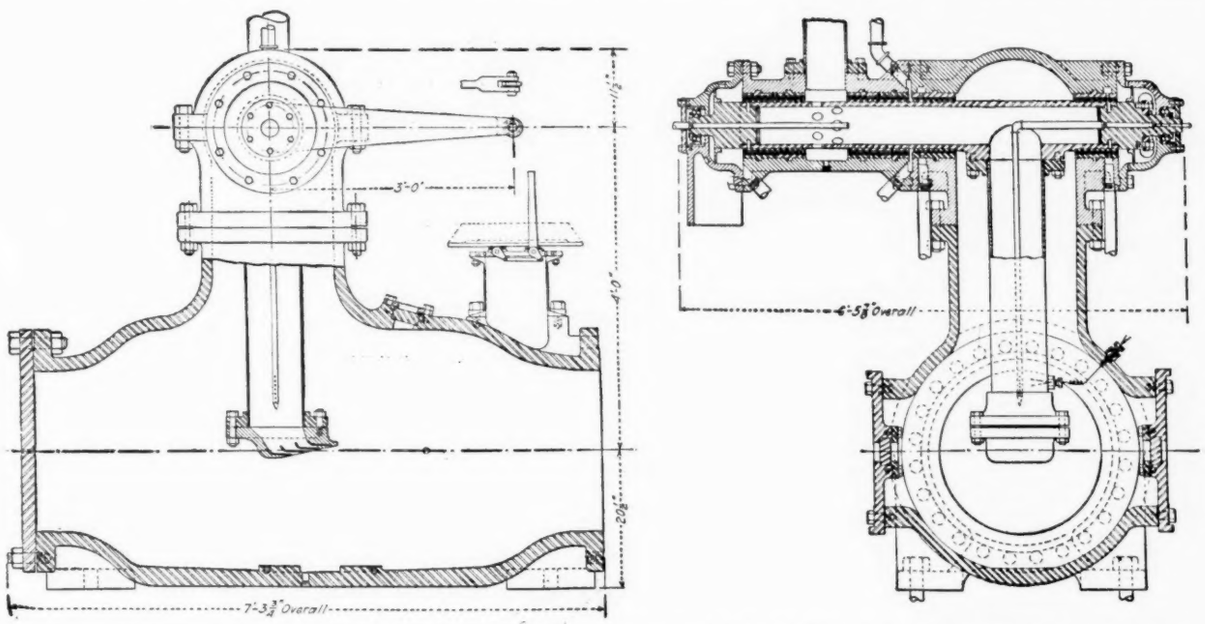


Fig. 1—Side and end elevations of the testing machine. Attention is directed to the dimensions of the apparatus

*Abstract of paper presented at the Midwest Power Conference of the A.S.M.E., Jan. 26 to 29, 1926.

†General Electric Co., Schenectady, N. Y.

[1] An Experimental Investigation of Nozzle Efficiency. *Trans.*, A.S.M.E., vol. 46 (1924), p. 981.

When the exhaust-chamber pressure is below atmospheric pressure, it is necessary to bleed a small quantity of steam into this packing in order to maintain the condenser vacuum. The steam so introduced is first measured by means of a calibrated orifice and the weighted flow is corrected accordingly.

Because of the uncertainty of leakage corrections main condenser leakage is never tolerated. The condenser tubes are carefully packed and a test is made twice each day for leakage. This test consists of weighing the water pumped from the condenser under full vacuum when all steam inlets have been shut off. All flow must cease within 45 minutes or the condenser is opened and inspected.

The air removed from the condenser while the machine is in operation is cooled below room temperature, and the condensed vapor is drained to the hotwell where it is mixed with the main condensate.

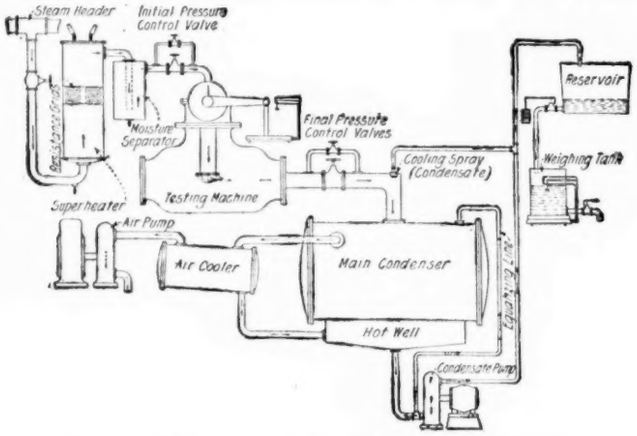


Fig. 2. Diagram of steam and condensate system of nozzle-testing machine

Pressure measurements are made in all cases with mercury columns. The ordinary U-tube is used for pressures less than about 6 in. of mercury gage; above that the pressure is applied to a mercury surface in a reservoir whence the mercury is forced up into a long tube. The pressure lines leading to the reservoir are filled with water to prevent condensation in them. Corrections must consequently be made for water columns as well as for the differential expansion between the mercury column and the scale with change in temperature.

Two entirely separate measurements are made of both the initial and final pressures and a direct measurement of the pressure differential across the nozzle is made whenever it is less than 60 in. of mercury.

The initial temperature is obtained by means of carefully calibrated thermocouples in the supply pipe immediately before the nozzle casting. The thermocouple cold ends are maintained at the freezing point of water, and the electromotive force generated is measured by a potentiometer.

The authors discuss very fully the details of the machine and its test operation. Elaborate precautions are taken to eliminate or correct for all known sources of error, which are both numerous and intricate.

Method of Testing

A single point on Fig. 3 or 4 represents a test of from one-half to one hour duration. The test is usually preceded by a period of 15 to 30 minutes' operation in order to bring the flow to an equilibrium value. The reaction, the pressures and the initial temperature are read at three-minute intervals; the flow is measured at six-minute intervals. The deviations from each other of the five or more flow readings that are taken during a test must not exceed one per cent and are usually considerably less than one per cent. The averages of these readings taken during the test are then converted into the final form, embodied in curves such as those of Figs. 3 and 4.

The average velocity of a jet leaving a nozzle is equal to the ratio of the reaction of the jet to the mass flow per unit time. The velocity coefficient is the ratio of the actual jet velocity to the theoretical velocity that would result from isentropic expansion. The flow coefficient is similarly the ratio of actual to theoretical flow, in pounds per unit time. The efficiency of a nozzle is slightly higher than the square of its velocity coefficient, the difference being only a fraction of one per cent.

The theory of flow is discussed with respect to the sources of reaction forces. The discussion is detailed and can hardly be abstracted.

In the results shown in Figs. 3 and 4 one of the outstanding features is the high velocity coefficients shown by both

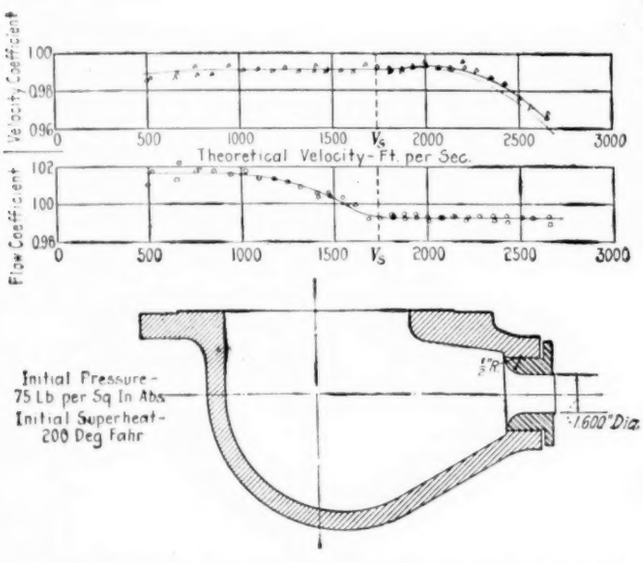


Fig. 3. Test results of a normal-outlet converging nozzle

The velocity of sound is indicated as V_s. The calculated velocity coefficient curve is shown as a dot and dash line. The velocity coefficient is the ratio of the actual jet velocity to the theoretical velocity. The flow coefficient is the ratio of actual to theoretical flow.

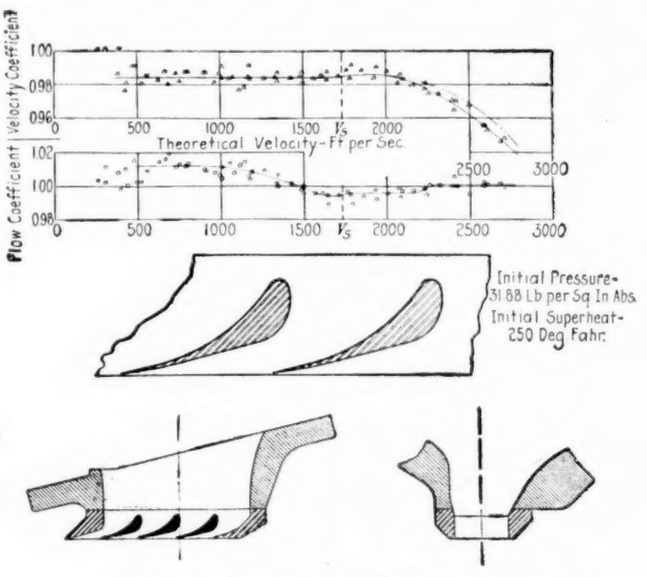


Fig. 4. Test results on a turbine nozzle

The velocity of sound is indicated as V_s. The calculated velocity coefficient curve is shown as a dot and dash line. Because of the very small reaction at 300-ft. per sec., an error of 1.5 per cent could readily occur in that measurement. This probably accounts for the high velocity coefficient points at that velocity.

the elementary nozzle and the turbine nozzle. The painstaking investigation and study involved in the development of this machine justify confidence in the results. However, a further check was available in the impact-tube air test described in Mr. Wirt's paper. The turbine nozzle shown in Fig. 4 was carefully tested by the impact tube method, and the differences between the two sets of data are well within the probable error of the impact-tube method..

Another feature of interest is the constant velocity coefficient shown by both the elementary nozzle and the turbine nozzle for all velocities below the velocity of sound. This characteristic is checked by the air-test data and has been verified by a series of impact traverses taken at different velocities along the center line of similar nozzle groups.

A constant velocity coefficient means constant efficiency, which in turn means that the friction forces involved are proportional to the square of the velocity. This is in agreement with nearly all the existing higher velocity tests on the resistance to flow of a fluid past flat plates, spheres, cylinders, airplane struts, etc.

Above the velocity of sound the test curves shown are compared with the values calculated from theoretical considerations. For the elementary nozzle the test curve and the calculated curve almost coincide, while for the turbine nozzle the slight disagreement between the two is due to the upward-reaction component that accompanies jet deflection in an oblique-exit nozzle and serves to lower the actual test curve. The fact that this effect was not considered in the calculation accounts for the difference between the test curve and that calculated.

The experience acquired in five years of almost continuous operation of this machine impresses one with the difficulties involved in the development of an apparatus of its kind to give not only the relative efficiencies of several nozzles, but dependable absolute efficiencies as well. A belief that any errors that still exist are of minor importance is justified by the experience that has been acquired, the many difficulties overcome and the agreement of the results wtih logical considerations.

New Developments in High Vacuum Apparatus*

By G. L. Kothny†

THE paper records the more important developments in the design and performance of the steam-jet air ejector made during the last six years. Such devices are classified as either low-vacuum ejectors (vacua up to 25½ in.), single stage; or as high-vacuum ejectors (vacua above 25½ in.), two-stage straight, two-stage with inter-condensers, two-stage with combined inter- and after-condensers, and augmenters.

Two-stage ejectors without inter-condensers have undergone no radical changes in design, and development has been confined to the improvement of steam economy. By arranging an inter-condenser between the first and second stages, the steam consumption of the two-stage ejector can be reduced about 50 per cent. This gain is in the second stage, whose steam nozzles are correspondingly reduced in capacity. This has the disadvantage of reducing the capacity of the second stage, which is used alone for evacuating the condenser from atmospheric pressure to about 21 in. of vacuum. The smaller second stage requires about two and a half times as long to accomplish this as the second stage of an ejector having no inter-condenser.

The figure illustrates the performance characteristics of three different types of air ejectors, all having the same steam consumption. The ordinates, giving the amount of air compressed in pounds per hour, are therefore proportional to the air compressed per pound of steam. Curves *A* and *B* of the inter-condenser ejector cross at point 1, indicating that with an ejector of this type there is no advantage in operating the first stage when the vacuum is less than 21 in. Curves *C* and *D* cross at point 2, indicating that with an ejector having no inter-condenser there is no gain from operating the first stage when the vacuum is less than 25½ in. Curves *D* and *A* intersect at point 3, showing that above 5½ in. absolute pressure the second stage of the two-stage ejector without inter-condenser has larger air-handling capacity than the two-stage ejector with inter-condenser.

From these curves the following conclusions are drawn:

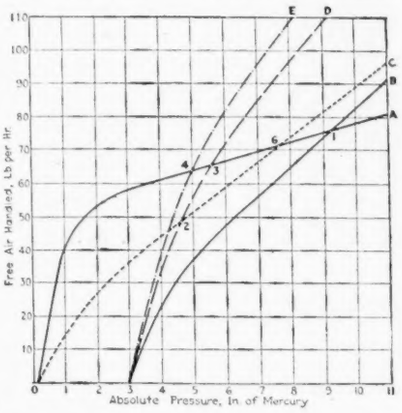
1. From 0.2 to 5½ in. absolute pressure the ejector with inter-condenser has larger capacity than the two-stage ejector without inter-condenser, or the single-stage ejector.

2. For absolute pressures of 5½ in. and higher the second stage of the ejector without inter-condenser has greater capacity than the inter-condenser ejector. For absolute pressures above 5 in. the single-stage ejector should be used.

3. Owing to the fact that the air-handling capacity of the second stage of an ejector with inter-condenser is small, the time required for evacuation of the condensing plant will be greater. If rapid evacuation is desired an additional single-stage ejector should be supplied.

For proper performance of an air ejector it is essential to use high pressures and dry saturated or superheated steam. Back pressures exceeding ½ lb. per sq.in. gage should be avoided. It appears that the volumetric capacity of an air ejector increases at lower absolute pressures, a desirable feature.

An important development is that of the low-pressure steam-operated vacuum augmenter. This was invented by Sir Charles A. Parsons in 1903, and has since been applied for a number of installations. In 1917 a modification was developed to operate on exhaust steam at a pressure of from 3 to 5 lb. per square inch gage, and proved very successful and highly economical.



Performance of air ejectors, all having the same steam consumption

A. Two-stage with inter-condenser, both stages operating. *B*. Same as *A*, but with only second stage operating. *C*. Two-stage without inter-condenser, both stages operating. *D*. Same as *C*, but with only second stage operating. *E*. Single-stage ejector.

The paper includes a discussion of details of design and describes a number of installations, with numerous illustrations and curves.

Florida and Georgia Projects—Ernest L. Hill and C. Lyman Spencer, of Jacksonville, Fla., have applied for preliminary permits covering five projects in Florida and southern Georgia, which will develop an aggregate of 26,000 net ten-hour horsepower at low water during the average year. One and three-quarters miles above Bradford, Fla., on the Suwannee, a head of 35 ft. can be developed, the application states. Another dam and power house is planned for a site four miles east of White Springs, Fla., on the same river. A head of 66 ft. is available at that point. At Troders Hill, on the St. Mary's River, a head of 40 ft. is to be developed. At Trail Ridge a head of 61 ft. is available from waters drawn from Cedar Creek and the three prongs of the St. Marys. Another stage of the development is to take place in the Okefenokee Swamp. The project there called for low dykes with six miles of canal to the power house. In this way a head of 19 ft. can be made available.

Pit River Project—The Mt. Shasta Power Corp., which holds the preliminary permit covering a project on the Pit River near Redding, Calif., has made application for license. The preliminary permit was issued May 5, 1923. The primary power that will be made available under the corporation's plan of development will be 56,880 hp. It is planned, however, to install three 40,000-hp. units. A part of the power will be marketed by the corporation itself. The rest is intended for the Pacific Gas and Electric Company.

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*Abstract of a paper read at the meeting of the Society of Naval Architects & Marine Engineers, held in New York, Nov. 12 and 13, 1925.

†Executive engineer, C. H. Wheeler Manufacturing Co.

Recent Publications

Judging Coal Values; The Practical Problem of Selecting and Buying Eastern Coals, 2nd edition, by Gerald B. Gould, vice-president, Fuel Engineering Co. of New York. Cloth, 8 x 6 in.; 56 pages; maps and colored illustrations.

The purpose of this book, it is frankly stated in the Preface, is not to contribute to engineering literature in the ordinary sense, but to put in plain English that can be understood by a business man, the more important facts and principles in regard to the selection and use of coal and their practical significance to him. The principal change from the first edition is found in the new Chapter VI, which embodies an analytical study of the bituminous-coal market under normal conditions.

What the Coal Commission Found. By E. E. Hunt, F. G. Tryon, J. H. Willits and others of the staff of the United States Coal Commission. Size, 5½x 8 in., 416 pages; illustrated. Published by the Williams & Wilkins Co., Baltimore, Md. Price, $5.

The United States Coal Commission was appointed by President Harding in 1922, and after nearly a year's intensive study brought out an exhaustive report aimed to serve as the basis of such policies as might be deemed expedient. The complexity of the industry and the limited time precluded the issuance of any digest such as might be easily comprehended by the public. The present book is an attempt to interpret the basic facts found by the Commission in the form of an easily understandable and human interest story. In this the authors have succeeded admirably.

Part I deals with the bituminous industry, showing how the coal is mined and sold, average costs and profits, miners' wages and how they live. A chapter is also devoted to the conditions leading up to strikes.

Of more particular current interest, owing to the present strike, is Part II, devoted to conditions in the anthracite industry. In contrast with the bituminous fields, where there are over 12,000 operating companies, the anthracite is mined by 174 companies, of which 8 produce 74 per cent of the output. These eight are closely affiliated with the railroads and control 90 per cent of the underground reserves.

The anthracite miners, unlike those in the bituminous fields, live largely in incorporated towns and villages, and more than 90 per cent of the houses are not owned by the companies. This is in strong contrast to the conditions in the bituminous fields. The average daily earnings of the anthracite miner range from $3.75 for boys and helpers to $6.20 for timbermen. The outside men work on an average of 325 days a year and the inside men 299, barring strikes. This, again, is much higher than in the bituminous field.

The book gives an excellent insight into the conditions of the industry, from the viewpoints of both the company and the miners, and after having read it one will be in a much better position to pass intelligent judgment on the relative claims of the parties to the present controversy.

The Theory and Practice of Combustion. By J. E. Lister and C. Harman Harris. Published by D. Van Nostrand Co., 8 Warren St., New York City. Printed in Great Britain. Cloth; 5x7½ in.; 150 pages; 22 illustrations; 26 tables. Price $2.00.

In compact and readable form this little book will give the reader a very fair knowledge of the elements of combustion. The treatment is clear and simple and does not require any knowledge of mathematics beyond ordinary arithmetic and the use of simple formulas. The first part of the book covers the elementary theory in fairly complete fashion. This is followed by chapters on fuels, indicating and recording instruments, practical considerations, and furnaces and stokers.

The Bureau of Mines Orsat Apparatus for Gas Analysis. By A. C. Fieldner, G. W. Jones and W. F. Holbrook. Technical Paper 320 of the United States Bureau of Mines. Paper pamphlet; 18 pages, Five cents. Sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C.

This bulletin, as the name implies, describes in detail the Bureau of Mines Orsat for gas analysis. This apparatus determines carbon dioxide by absorption in caustic soda, illuminants by absorption in fuming sulphuric acid, oxygen by absorption in pyrogallate acid, carbon monoxide and hydrogen by passing the gas through a heated tube containing copper oxide, methane and ethane by combustion in a special pipette provided with a platinum ignition wire. The construction of this apparatus is described in such detail that it could be built from the information given. The value of the booklet is increased by an introduction discussing the factors that may affect the accuracy of analysis and by sections describing in detail the operation of analysis and the preparation of absorbents. A table in the back of the pamphlet gives reliable combustion data on thirty-one different substances.

The Ruths Steam Accumulator, by Alfred J. Taylor. This is a reprint of a paper given before the Institution of Engineers and Shipbuilders in Scotland on Oct. 6. and contains, besides the description of the apparatus, a bibliography on the subject. Copies of this paper are available by application either to the Ruths Accumulator Co., Inc., 292 Madison Ave., New York City, or through Combustion Engineering Corp., Bank of Hamilton Bldg., Toronto, Canada.

The A.S.M.E. Computation and Report Sheets for Test Code for Stationary Steam Boilers are now available at the A.S.M.E., 29 West 39th St., New York City, at $1 for a pad of 25 sheets. There are four forms which are all entitled, "Data and Results Including Heat Balance Computation, Solid Fuels — Air Fired-Dry." "A" form is a short form; "B" covers Steam Generating Units Comprising Boiler and Superheater with or without integral economizers; "C" Steam Generating Units Comprising Boiler, Superheater and Economizer; "D" form, "Steam Generating Units Comprising Boiler, Superheater, Economizer and Air Heater."

Screen Sizing of Coal, Ores and Other Minerals, by E. A. Holbrook and Thomas Fraser, is Bulletin 234 of the Bureau of Mines. It represents work done under a co-operative agreement between the Bureau of Mines, Department of the Interior, the State Geological Survey, Division of the State of Illinois, and the Engineering Experiment Station of the University of Illinois. A limited number of copies are available for free distribution; when these are exhausted, a charge of 40 cents will be made. Applications should be adressed to the Superintendent of Documents, Government Printing Office, Washington, D. C.

Industrial Water Supplies of Ohio. Bulletin No. 29 of the Geological Survey of Ohio, J. A. Bownocker, state geologist, Columbus, Ohio, contains chapters on impurities in water, methods of analysis and the statement of results and their interpretation, the behavior of water in use and the industrial purification of water by C. W. Foulk, professor of analytical chemistry, Ohio State University. The first section of this book is of such general interest and practical value as to warrant an extensive review. This will appear in an early issue. Part II contains chemical character of the surface water of Ohio and Part III chemical character of the ground waters of Ohio. It is cloth bound, has 406 pages and costs $1.

Bureau of Public Utilities of the City of Buffalo, Report for the Fiscal Year Ending, June 30, 1925, George S. Macomber, director, 332 Ellicott St., Buffalo, N. Y. This report contains the principal operating statistics of all public-utility corporations serving the City of Buffalo for the year 1924 as well as comparative figures for five years previous.

St. Lawrence and Southern Hudson Bay Drainage, (Eastern Section) Quebec. Water Resource Paper No. 41 covering the climatic year 1922-23 by Leo G. Denis, was prepared under the supervision of the Director of Water Power and Reclamation, and has been published by the Department of the Interior, Ottawa, Canada. A good map is included.

National District Heating Association. Proceedings of the Sixteenth Annual Convention held at West Baden, May 18-22, 1925. Published by the Association, D. L. Gaskell, Sec., Greenville, Ohio.

News in the Field of Power

Electrical Engineers Hold 14th Midwinter Convention

Protection and control of electrical machinery and busbar construction were among the subjects discussed at the 14th Midwinter Convention of the American Institute of Electrical Engineers, held in the Engineering Societies Building, New York City, with an attendance of about 1,500, Feb. 8 to 11. Eight technical sessions were held, at which 35 papers were presented. In the Belvedere of the Hotel Astor on Tuesday evening an informal smoker and entertainment was enjoyed by a large number of the members and their friends. Wednesday evening was the occasion of the usual pleasant social feature, the dinner dance at the Hotel Astor which was well patronized.

On Thursday evening in the auditorium of the Engineering Societies Building, two intensely interesting lectures, on subjects which engineers do not often have a chance to hear, were delivered. Dr. Alexis Carrel, widely known for his accomplishments in the field of medical and biological research gave a talk, which was illustrated by motion pictures, on "Some Developments of Biological Research." The other speaker was Major Allen Carpe, who described by a talk and motion pictures the ascent of Mount Logan, the highest peak in the Canadian Rockies. It was evident that engineers are interested in subjects other than those pertaining to their own profession, as the auditorium was filled to capacity.

A wide variety of inspection trips were arranged to such points of interest as the new Kearny power station of the Public Service Electric Power Co., Newark, N. J., the Hudson Avenue station of the Brooklyn Edison Co., the Hell Gate and the Sherman Creek power stations of the United Electric Light and Power Co.; the Edison Lighting Institute, the Holland vehicle tunnel now nearing completion between New York and Jersey City; the Bell Telephone Laboratories; WEAF broadcasting station of the American Telephone & Telegraph Co.; and a machine switching control office of the New York Telephone Company.

A paper of particular interest to power-house engineers was that presented by F. H. Kierstead, "Current-Limiting Reactors with Fireproof Insulation on the Conductors." Tests have shown that if conducting material lodges between the turns of a reactor having bare copper conductors, as the earlier type had, the reactor will flash over at the instant a failure occurs on the circuit in which the reactor is located. In presenting the paper, Mr. Kierstead showed with moving pictures the tests that were made on reactors when developing the insulation for the conductors. Iron nails, bolts and nuts that were left on the floor within a few feet of the reactor would be picked up by the magnetic field and drawn into the reactor during the period of abnormal current, and cause flash overs. In developing an insulation for the conductors, it was necessary to find something that would not only stand the voltage and temperature conditions of the reactor, but would also withstand without injury the cutting or piercing action of the iron object that might be drawn into the reactor. This insulation material is a braided asbestos, almost 100 per cent pure.

"Carrying Capacity of 60-Cycle Buses for Heavy Currents," was the title of a paper presented by Titus G. LeClair. In any direct-current circuit the current in a laminated or stranded conductor will divide in all parts in proportion to their resistance. With alternating current flowing in the circuit this does not hold true. This is due to the so-called skin effect. Where conductors of two or more phases are placed near to each other, there is also the effect of one conductor's magnetic field on another. As a result of a series of experiments made by the Commonwealth Edison Co., and given by Mr. LeClair in his paper, that company has adopted a box-type busbar made up of four bars arranged in a hollow square and the three busbars for a three-phase circuit mounted in an equilateral triangle. This design makes possible the design of busbar structures up to 8,000 amperes capacity, whereas with the usual type of structure 3,000 was about the limit.

In a paper on "Supervisory Systems of Electric Power Apparatus," Chester Lichtenberg described the various systems for controlling power equipment from a distant point. With the supervisory systems a load dispatcher can start up or shut down a distant substation or hydro-electric plant, open and close the oil switches and get a reading of the meters in his office. All this can be done over two or three wires, or the carrier-current system may be used, in which case the transmission line is made use of. A supervisory control system is now being installed that will give the load dispatcher control of the circuit breaker in 25 different stations.

If heavy alternating-current conductors are run close to steel or iron structural members, they will heat owing to the alternating magnetic field inducing eddy currents in them and to the hysteresis losses. While these effects have been generally known, there has been a scant amount of data available for designers to estimate the temperature rise and losses occurring from such causes. The results of an extensive series of experiments were given by O. R. Schurig and H. P. Kuehni in a paper on "Temperature Rise and Losses in Solid Structural Steel Exposed to the Magnetic Fields of Alternating-Current Conductors."

N. Y. State Troubled by Power Leases and Reorganization

In a resolution introduced on Feb. 8 in the Assembly, the New York State Water Power Commission was called upon not to take any action on leasing power sites on the Niagara or St. Lawrence Rivers until after the report of the Hughes Commission, which is planning a reorganization of the state government. On Feb. 25 the Water Power Commission is expected to give a hearing on the proposed lease of the St. Lawrence power.

According to the resolution, the Water Power Commission is planning to license private corporations to develop 500,000 hp. on the Niagara River and 1,000,000 hp. on the American side of the St. Lawrence River.

Shoals Excess Power Must Be Distributed, Says McKellar

No proposal for the disposition of Muscle Shoals can pass unless it provides for the equitable distribution of the power not needed for fertilizer manufacture within the full radius in which it can be transmitted economically. This opinion was expressed by Senator McKellar of Tennessee, after a partial poll of the Senate.

When the House resolution, providing for the joint Congressional committee which is to receive bids, comes before the Senate strenuous efforts will be made to amend it.

If the resolution passes, as seems likely in view of the determined way in which it is being championed by the President, it seems probable that any offer made under its terms will have to provide for the use of all power not actually required in fertilizer manufacture, for public utility purposes.

Even if the resolution passes, efforts will be made in the Senate to secure action along different lines. It is becoming more generally known that there is no need to dispose of the power structures at bargain prices. Legislation will be introduced vesting the Federal Power Commission with the responsibility of allocating all power.

A portion of the revenue derived from the power under this legislative proposal would be used under the direction of the Secretary of War and the Secretary of Agriculture for experimental work on nitrogen fixation processes and on other fertilizer ingredients. Those favoring legislation of this type feel that the uncertainties of fertilizer manufacture are such that no desirable offer is likely to be forthcoming for the nitrate plant alone.

Experimentation with fertilizer processes may not be confined to government activities, as one bill provides opportunity for individual inventors.

St. Louis Engineers Confer to Stop Smoke

On the evening of Feb. 5 at the Chamber of Commerce the citizens of St. Louis held a joint smoke abatement conference under the auspices of the Women's Smoke Abatement League, the St. Louis Section of the A. S. M. E., and the Associated Engineering Societies of St. Louis. Smoke abatement through co-operation was the general topic and the principal speaker, Dr. O. P. Hood, chief engineer of the Bureau of Mines, Washington, D. C. About 300 were in attendance, and Erle F. Ormsby, chairman of the Public Affairs Committee of the A. S. M. E., presided. W. L. Abbott, of Chicago, president of the society, had been invited and participated in the discussion of the evening.

As expressed by Doctor Hood, the six elements of a successful smoke abatement campaign were: Aroused public opinion and support, vision and foresight on the part of unselfish civic workers, continuous and untiring effort in carrying out the campaign, technical ability of inspectors; tact, executive ability, and sound business judgment of leaders in the movement, and co-operation of the right kind by unintentional or intentional offenders.

Continuing, Dr. Hood emphasized in particular the necessity for continuous pressure. "The campaign to rid the city of smoke," he said, "must never be allowed to lag or die. It will be necessary to keep at it until the citizens of St. Louis are convinced that the city must be freed from smoke. The business men must be shown that less smoke means more prosperity for them. The big thing is to make up your mind that the soft coal used in the city can be burned without making undue smoke, as is the case in other cities. Then continue the fight until everyone else is in agreement with you."

A plan for smoke abatement that had found favor with the Bureau of Mines consisted of establishing a commission of far-seeing civic leaders to further the project, the selection of a Board of Engineers to act in an advisory capacity to the commission and the formation of a working organization, consisting of a smoke commissioner and a staff of inspectors. As the first step to be taken by the commission, Doctor Hood recommended a smoke survey of the community, so as to lay a basis on which future progress of the campaign might be determined. Incidentally, this would fix responsibility for the smoke in the city by showing from what places the smoke was coming.

Following Doctor Hood numerous other speakers participated, including Prof. E. C. Schmidt, of the University of Illinois; J. H. Brod, Jr., Director of Public Safety of St. Louis; John H. Gundlach, chairman of the Chamber of Commerce Smoke Abatement Committee; Prof. Louis Berger, Victor J. Azbe, and Mrs. Lon O. Hocker and Mrs. Harvey G. Mudd, co-chairmen of the Women's Smoke Abatement Committee.

As a fitting conclusion to a most enthusiastic and successful meeting, resolutions calling for the formation of a citizens' smoke conference to promote smoke reduction and fuel economy were adopted. The conference is to consist of two representatives from fifteen civic, industrial and smoke abatement organizations, the Mayor, Director of Public Safety, the Smoke Commissioner and the president of the Chamber of Commerce.

Swiss Power Conference Aug. 31 to Sept. 12

The Swiss National Committee of the World Power Conference, with the permission of the International Executive Conference, will hold a sectional meeting in Bale, Switzerland, Aug. 31 to Sept. 12, in connection with the Navigation and Power Exhibition. The notice of a sectional meeting being held in England, which appeared in the Dec. 29 issue of *Power*, page 1029, was erroneous; it should have read Switzerland instead of England.

European countries have been asked to participate in an organized way. Other countries have been invited to have representatives in attendance, and papers submitted through their national committees will be incorporated in the proceedings.

It was the desire of the Swiss committee to make the affair a world conference, but the Executive Council felt that a sectional meeting was all that could be justified so soon after the World Conference in 1924 which was held at Wembley, England.

The main subjects to be considered at the Bale conference are: railway electrification; electricity in agriculture; exchange of electrical energy between countries; utilization of water power and inland navigation and the economic relation between electrical energy produced hydraulically and that produced thermally.

Anti-Smoke Campaign Catches Six N. Y. City Engineers

New York City authorities took the offensive in their campaign against the smoke evil when Magistrate Jean H. Norris imposed fines of $100 each on three building engineers for violation of the anti-smoke ordinance. These were the first fines in the campaign inaugurated by Dr. Louis I. Harris, Commissioner of Health. The next day three more received a $100 fine.

Magistrate Norris's action was forecast on Feb. 5 by Chief Magistrate William McAdoo, who gave warning that violators of the anti-smoke ordinance would be fined from $100 to $500 for each offense and that in extreme cases factories and industrial plants would be forced to shut down wholly or in part if they could not operate without endangering the health of the residents in their section.

The Chief Magistrate on Feb. 10 appointed a committee to draw up plans to minimize the dense smoke evil.

Experts Differ on Future Oil Supplies

Divergent views as to the future of the petroleum industry were expressed by prominent oil men at the opening of hearings on Feb. 10, before the Federal Oil Conservation Board. Expert opinions varied from predictions of a shortage in the not distant future to assertions that, by application of the most modern methods, as much oil might be recovered from known fields as has already been taken from them.

Secretary Work asked for opinions "whether there is sound reason for presuming there is, or is not, an inexhaustible supply of petroleum in the United States."

Henry L. Doherty, of New York, told the conference that petroleum was a wasting national asset, that twice as much was being consumed as was required by the market, and that in the event of war there was no certainty of an adequate supply.

Arguing for revision of laws affecting the industry, Mr. Doherty declared "a petroleum pool is by nature incapable of being divided up and operated according to the surface divisions that have arbitrarily been created. It must be developed as a unit to prevent both the waste of petroleum and gas and economic waste as well.

W. C. Teagle, president of the Standard Oil Co. of New Jersey, defended the use of fuel oil as a coal substitute, declaring economic laws could be safely left to determine when its use was most desirable.

J. O. Lewis, consulting engineer, Tulsa, stated that by modern pressure methods an average of a barrel of oil for every barrel already recovered could be forced from the oil sands.

J. Edgar Pew, of Dallas, said oil was being drawn from unusually deep strata and that production from a 10,000-foot depth was a possibility.

The Oil Conservation Board received suggestions for preserving the nation's oil resources preparatory to drafting its report to the President.

Production, Imports, Stocks, Exports and Domestic Consumption of Refined Gas and Fuel Oil and Lubricating Oil

Barrels of 42 Gallons

	Gas and Fuel Oil			Lubricating Oil		
	Nov., 1925	Dec., 1925	Dec., 1924	Nov., 1925	Dec., 1925	Dec., 1924
Production	29,280,000	30,906,000	28,549,839	2,630,000	2,711,000	2,485,502
Daily average	976,000	996,968	920,963	87,667	87,452	80,177
Imports	539,000	417,000	1,099,741	1,000	1,000	549
Daily average	17,967	13,452	35,476	33	32	18
Stocks:						
End of month	Not available	Not available	39,774,022	6,998,000	7,267,000	6,127,053
Increase during month	Not available	Not available	700,451	174,000	269,000	359,290
Daily average	Not available	Not available	22,595	5,800	8,677	11,590
Exports	3,174,000	3,482,000	2,666,393	706,000	947,000	691,903
Daily average	105,800	112,000	86,013	23,533	30,548	22,319
Indicated domestic consumption	Not available	Not available	26,282,736	1,751,000	1,496,000	1,434,858
Daily average	Not available	Not available	847,830	58,367	48,259	46,286

American Petroleum Institute

Lehigh Research Fellowships To Be Awarded

The Institute of Research of Lehigh University has announced that two fellowships in electrical, mechanical, or hydraulic engineering are vacant and that appointments will be made on or before June 1 for two academic years with an annual stipend of $750. These fellowships have been made possible by an endowment provided by the widow of Col. Henry M. Byllesby. The "Henry Marison Byllesby Memorial Research Fellows in Enigneering" is the name of the fellowships. Applications for appointment may be submitted by graduates in engineering or science of colleges, universities or technical schools. Additional information may be obtained from C. R. Richards, president, Lehigh University, Bethlehem, Pa.

Opposition Develops to Metric System Bill

Voluminous testimony has been taken by the Coinage, Weights and Measures Committee of the House of Representatives in support of Representative Britten's bill, providing for the compulsory use of the metric system for certain purposes, on and after Jan. 1, 1935. Numerous witnesses were introduced including Dr. Harvey W. Wiley, former chief of the Bureau of Chemistry; Dr. Charles L. Parsons, secretary of the American Chemical Society; Representative Britten, author of the bill, and Frederick L. Roberts, treasurer of the Metric Association.

Representatives of those opposed to the legislation made brief statements intended to demonstrate to the committee that the opposition to the legislation is general in many lines of industry and trade. Since they had only two days' notice of the hearing, an adjournment was asked so as to give them an opportunity to arrange for the appearance of outstanding men in industry. To this Chairman Perkins agreed. The date of the further hearings is to be fixed hereafter.

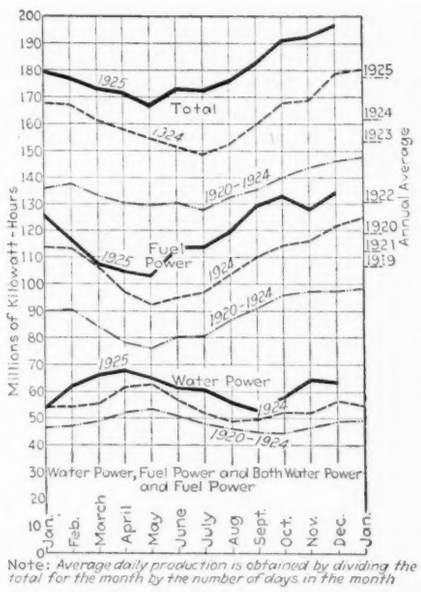
Air and Anthracite Fuel Beds Being Studied

A study of the pressure required to force air through anthracite fuel beds is being made by the Bureau of Mines. Little work has been done on the drop in pressure of fluids flowing through aggregates, although such flow occurs in many mineral production and utilization industries. The commonest example is the pressure drop necessary to produce a given rate of flow of air through a fuel bed, that is, to produce a given rate of combustion. The values required in practice are dependent on many factors and variables so that those assumed in computations are largely based on empirical rules. To obtain some of the fundamental values when the conditions are known, a careful study was made by the Bureau of the flow of air through anthracite of the various commercial sizes. The results have been worked up to form the groundwork for further investigations in which other variables will be introduced, and to permit of their being co-ordinated with the flow through aggregates having different shapes and sizes.

Increase in Production of Electricity in 1925

The total annual output of electricity by public-utility power plants in 1925 was 65,801,000,000 kw.-hr., an increase of 11.5 per cent over the output for 1924. Of this quantity, about 34 per cent was produced by the use of water power, a slight increase over the percentage for 1924. It would have required the consumption of 23,000,000 tons of coal to generate this 34 per cent, according to the records of the Geological Survey.

The average daily production of electricity for each month in this year by public-utility power plants and the proportion produced by water power were as follows: Jan., 179,700,000 kw.-hr., 30 per cent; Feb. 178,600,000 kw.-hr., 35 per cent; March, 173,900,000 kw.-hr., 38 per cent; April, 172,700,000, kw.-hr., 39 per cent; May, 169,000,000 kw.-hr., 39 per cent; June, 174,800,000, kw.-hr., 35 per cent; July, 173,500,000 kw.-hr., 35 per cent; August, 176,200,000 kw.-hr., 32 per cent; September, 183,000,000 kw.-hr., 29 per cent; October, 191,900,000 kw.-hr., 30 per cent; November, 192,900,000 kw.-hr., 33 per cent; December, 197,000,000 kw.-hr., 32 per cent.



Note: Average daily production is obtained by dividing the total for the month by the number of days in the month

Central Stations, Electric Railway Plants, and output of other Plants Generating Electricity for Public use

The amount of coal consumed in producing electricity in 1925 was only 7 per cent greater than in 1924. The amount of oil was 38 per cent less and the amount of gas was 4 per cent less than in 1924. Although the oil consumed amounted to more than 10 million bbl. and the gas to nearly 50 billion cu.ft., coal represented nearly 90 per cent of all the fuel used by electric power plants. The coal plus the coal equivalent of the oil, gas, and wood used in the generation of electricity by public-utility plants in 1925 amounted to about 45,000,000 tons, or an average of nearly 3,000 lb. a second, or 100 carloads an hour throughout the year.

The gain in efficiency in the use of fuel continued in 1925, as there was a decrease of about 0.1 lb. in the average consumption of coal per kilowatt-hour, compared with the rate of 1924. This apparently small gain amounts to more than 2,000,000 tons of coal for the year.

Water Resources Bill Meets Further Objections

The Secretary of War, reporting to the House Committee on Interstate and Foreign Commerce, on the bill authorizing the Geological Survey to make an inventory of the nation's water resources, says:

> The bill authorizes the Director of the Geological Survey to make an inventory of the water resources of the United States and to collect and publish data relating thereto. It also authorizes him to "report on the best method of utilizing the water resources." This latter provision is believed to be open to the construction that it authorizes the Geological Survey to prepare plans and projects for navigation, for flood control, for hydro-electric power, and for irrigation on all of the inland waterways of the United States.
>
> This Department is entrusted with the execution of navigation and flood control projects, and in the course of its long experience in works of this nature, it has acquired a knowledge and information to enable it to intelligently prepare plans for improvements of this character. This bill, if enacted as written, might be construed as authorizing the Geological Survey to prepare plans for improvements for navigation and for flood control projects, and thus bring about a duplication of effort.
>
> It is my opinion, therefore, that the bill should be modified by eliminating that provision authorizing the Geological Survey to report on the best methods of utilizing the water resources, and I have modified the inclosed copy of the bill accordingly.

The opinion of the Federal Power Commission concerning the proposed bill was published in *Power*, Jan. 12, page 79.

Gen. Harry Taylor, the Chief of Engineers, suspects that the Geological Survey would like to undertake the preparation of a complete survey of all of the streams of the country upon which power development is possible and prepare plans for such development. General Taylor makes this point:

> If I understand this correctly, hydraulic engineers in private practice could go out of business indefinitely, for at the end of twenty years, or thereabouts, not only would all the streams of the country have been surveyed, but complete plans for the development would have been prepared by the government, then it would only be necessary for anyone desiring to make a power development to apply to the government for the plans upon which to proceed.
>
> I am quite sure that it would be futile for us to try to work out complete plans for the development of all the hydro-electric resources of the country, present these plans to private capital, and expect it to go ahead on our say so. I am quite sure it would be an unwarranted blocking of our national development to forbid the exploitation of our streams for ten or twenty years, while we are making up our minds how it should be done. I am quite sure also that it would be an unwarranted extension of federal activities, to attempt to substitute ourselves for all the hydro-electric engineers of the country, by endeavoring, on a gigantic and ambitious scale, to perfect, all at once, a set of plans for the complete development of our power resources.

Bituminous-coal production "at high levels only occasionally reached in the industry" has been reported by the Bureau of Mines, which places the total at 13,073,000 tons during the seven days ending Jan. 16.

Engineers Wanted for Government Service

The United States Civil Service Commission announces open competitive examinations for associate engineer at $3,000, and assistant engineer at $2,400. Duties will be in aëronautic, ceramic, civil, electrical, marine, materials, naval architecture, radio, safety and other specialized branches of engineering. Papers will be rated as received, beginning March 15 and thereafter until April 30. Competitors will be rated on their education, training and experience. Information may be obtained from the Civil Service Commission at Washington or at any post office or custom house in any city.

Anthracite Coal Situation Outlook Unchanged

The anthracite coal strike, which is the longest general hard-coal strike on record, although the subject of a great deal of discussion during the past week, is still deadlocked.

Governor Pinchot, after having his proposed legislation denied him by the Pennsylvania Legislature, on Feb. 6 issued another statement citing instances of enormous profits made by some of the producing companies to show how the people are gouged in the prices they pay and hinted at the possibility of government ownership of the industry.

On Feb. 8 a bill was introduced into the Pennsylvania Senate calling for the creation of a permanent State Anthracite Coal Supply Commission to take over the direction of the operation of anthracite mines in time of strike, which was presented by Senator Charles Steele. The measure says its purpose "is not to encroach upon the rights of capital and labor in the settlement of industrial disputes, but to insure the users of a supply of anthracite coal in order to protect the health and welfare of the people of the Commonwealth and of the United States."

The Senate of the United States on Feb. 8, after having twice refused to consider such a step, succumbed to the growing pressure for action and adopted Senator Copeland's resolution asking for the President to call operators and miners into conference at the White House. The vote was 55 to 21.

This action did not meet with the approval of the President. The Administration's position is that federal intervention at this time would not accomplish anything toward a settlement and might only increase the bitterness of the dispute between the operators and miners. The Administration also contends that it is without power to "force" a settlement of the strike. The President made it clear that had he possessed such powers he would have acted at the outset of the strike, but that he had refrained because he was without legal authority to compel an adjustment.

Secretary of the Treasury Mellon, in response to the La Follette resolution, presented to the Senate figures on the taxes of the anthracite mining companies. The figures show that of the 169 companies actively engaged in the mining, dredging, washing or production of anthracite in 1924, only 46 showed a profit, while 93 of these companies had a net loss for the year or the nearest corresponding fiscal year. The greatest profit was shown by the Glen Alden Coal Co., of Scranton. Its returns carried a net profit of $7,809,069. The Harleigh Brookwood Coal Co. carried the greatest loss. The figures were $648,779.

Crude-Oil Production Increases

The daily average gross crude-oil production in the United States for the week ended Feb. 6 was 1,906,250 bbl., as compared with 1,892,900 bbl. for the preceding week, an increase of 13,350 bbl. The daily average production east of California was 1,298,250 bbl., as compared with 1,280,900 bbl., an increase of 17,350 bbl., according to the American Petroleum Institute. Imports of petroleum (crude and refined oils), at the principal ports for the month of January totaled 5,401,000 bbl., a daily average of 174,226 bbl., compared with 5,134,000 bbl., a daily average of 165,613 bbl. for the month of December.

Imports at the principal United States ports for the week ended Feb. 6 totaled 1,043,000 bbl., a daily average of 149,000 bbl., compared with 1,312,000 bbl., a daily average of 187,429 bbl. for the week ended Jan. 30.

Personal Mention

E. W. Johnston, King's College Hospital, England, has been elected president of the Diesel Engine Users' Association for the coming year.

F. J. Teago has been appointed by the Liverpool University Council to the Robert Rankin chair of electrical machinery.

Herman Sigrist is located at Mexico City, as mechanical engineer for the Mexican Light & Power Co., Ltd. He was previously in a similar position with the Allis-Chalmers Mfg. Co. at Milwaukee.

Ollison Craig, who was formerly research engineer of the Underfeed Stoker Co., and later held this same position in the consolidated firm of the Underfeed with the Riley Stoker Corp., has recently become consulting engineer for the Riley Stoker Corp.

J. F. Lincoln, executive vice-president of the Lincoln Electric Co., of Cleveland, has just started on a six-weeks trip which will take him to New York City, important points in North Carolina, New Orleans, Houston, Fort Worth, Oklahoma City, El Paso, Phoenix, Los Angeles, San Francisco, Portland, Seattle, Duluth, Kansas City, Chicago and other large centers.

Sidney Richard Inch, formerly general manager of the Utah Power & Light Co., has been elected president of the Florida Power & Light Co., which has recently been organized as the operating company for the Florida properties under the supervision of the Electric Bond & Share Co. Mr. Inch removed to the New York office of the Electric Bond & Share Co. in 1923, where he will maintain his headquarters.

K. H. Smith, of Halifax, has resigned as chief engineer of the Nova Scotia Power Commission, with which he has been connected since its inception. **Harold J. Johnson** has been appointed chief engineer to succeed Mr. Smith. Mr. Johnson has been hydraulic engineer associated with Mr. Smith in the developments of the Commission.

Society Affairs

The Connecticut Section of the A.I.E.E. will hold its March 9 meeting at Hartford. "Power Production," will be the subject.

The Empire State Gas & Electric Association will hold its annual meeting at the Hotel Van Curler, Schenectady, N. Y., Mar. 3-4. Papers of interest to *Power* readers will be: "Precaution to Be Taken in Installing Waste Heat Boilers—Back Run"; "Uses of Gas"; "Gas Refrigeration."

The Connecticut Section of the A. I. E. E. will hold a meeting on Feb. 16 with the Fairfield County Engineers Association at 351 Atlantic Ave., Stamford, Conn. Karl Fenning, special assistant to the Attorney General, Department of Justice, Washington, D. C., will speak on the "Value of Patents."

The Boston Section of the A. S. M. E. will hold a Symposium, at the Engineers Club, 2 Commonwealth Ave., on "Some of the Problems Involved in Layout and Design of High-Pressure and High-Temperature Piping for Industrial and Power Plants," by Frank S. Clark, who will outline the subject which will be followed by a general discussion on Feb. 18.

The Institution of Fuel Economy Engineers is the name of a new organization recently formed in England with the object of dealing in a scientific manner with the problem of preparing and utilizing the fuel resources of the country efficiently. At the recent inaugural meeting of the Institution the first council was elected, and it was decided to form sections in different parts of the country. The ideal behind the new Institution is said to be that it shall be the responsible organization, representing every section of fuel technology throughout the country. The secretary is H. L. Pirie, 29 Sherwin Rd., Lenton, Nottingham, England.

Business Notes

The General Electric Co., Schenectady, N. Y., announces the appointment of Earl S. Henningsen and P. L. Alger as assistant engineers of the alternating-current engineering department, Schenectady, N. Y.

The Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., announces that Robert J. Beler has recently joined the Pittsburgh sales office as assistant to W. G. Kerr, district representative.

The Ingersoll-Rand Co., 11 Broadway, New York City, has established a warehouse, a service and parts station at 20 Washington St., near the main office in lower Manhattan.

The American Steel & Wire Co., 208 South La Salle St., Chicago, Ill., announces that H. S. Durant has been appointed manager of the cold-rolled strip and spring sales department in Chicago, succeeding Lewis Johnson, deceased.

The Moore Steam Turbine Co., Wellsville, N. Y., announces that Young C. Smith has been appointed as district sales representative for the Detroit district with offices at 220 General Motors Bldg., Detroit, Mich.

The Bundy Steam Trap Co., Nashua, N. H., announces the appointments of William S. Corcoran, 29 North Second St., Harrisburg, Pa., and the Steam Economy Co., Indianapolis, Ind., as its exclusive agents in the respective territories.

The Chain Belt Co., Milwaukee, Wis., announces changes in its organization: J. W. Millspaugh, assistant works manager, has been advanced to works manager to succeed J. C. Merwin who was elected second vice-president; Fred Kau is now assistant to Mr. Millspaugh.

The Lee B. Mettler Co., 406 South Main St., Los Angeles, Calif., announces the appointment of the Automatic Safety Appliance Corp., 53 Park Place, New York City, as its representative in the states of New York and New Jersey, eastern Pennsylvania and the New England States.

The Graybar Electric Co., Pershing Sq. Bldg., 100 East 42d St., New York City, announces new appointments: W. O. Ramsburg will be general service manager; G. E. Chase broadcasting sales manager; A. J. Evans, carrier telephone sales manager; R. M. Hatfield, public address sales manager.

The Taylor Instrument Companies, Rochester, N. Y., are celebrating their 75th anniversary of organization. An inventory taken 74 years ago shows a total of $919 capital, of which $600 was good will. A small beginning, but coupled to vision and ideals of quality and service, it has resulted in this internationally known company of today.

Trade Catalogs

Hangers — Crouse-Hinds Co., Syracuse, N. Y. Flexible fixture hangers for condulets are shown in Bulletin No. 2084, which supersedes No. 2063.

Gaskets—Metallo Gasket Co., 12 Bethany St., New Brunswick, N. J. Catalog 26, recently issued, contains information regarding the packing material manufactured by the company for high steam pressures and temperatures. Illustrations and price lists are included.

Power Plants—Shevlin Engineering Co., Inc., Maspeth, Borough of Queens, New York City. Catalog showing the character of work done by the engineering firm in installations of mechanical and power-plant equipment, piping, boiler casings, coal- and ash-handling apparatus and other construction.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., May 31-June 2.

American Chemical Society. Charles L. Parsons, Mills Bldg., Washington, D. C. Convention at Tulsa, Okla. April 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at The Homestead, Hot Springs, Va., May 24-27.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association**, F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Ohio State Association**, T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association**, George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **New Jersey State Association**, S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association**, Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Steam Generator — International Combustion Engineering Corp., Broad St., New York City. Pamphlet describing and illustrating this new type of boiler recently announced as being manufactured by the company.

Furnaces — Combustion Engineering Corp., Broad St., New York City. Catalog FF-1, recently issued, covers the fin furnaces; a water-cooled furnace which was placed on the market two years ago. Illustrations and drawings are included.

Power Scraper — Sauerman Bros., Inc., 438 South Clinton St., Chicago, Ill. Catalog No. 8 is a brief on the storage of coal and other bulk materials with power scrapers. It presents methods of operation, details on the hoist bucket and other equipment, power requirements, handling capacities and other data, with an interesting collection of illustrations showing installations.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Feb. 8 1926
Pool 1	New York	$2.85@$3.25
Smokeless	Boston	2.10
Clearfield	Boston	1.90@ 2.25
Somerset	Boston	2.00@ 2.35
Kanawha	Columbus	1.45@ 1.80
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.15@ 1.25
Franklin, Ill.	Chicago	2.35@ 2.65
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.35
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.75@ 2.25
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	*None in Market*
Buckwheat No. 1.	Philadelphia	
Birdseye	New York	

FUEL OIL

New York—Feb. 11, light oil, tank-car lots; 28@34 deg. Baumé, 5½c.@ 5¾c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 5, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.53c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Feb. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Feb. 5, f.o.b. local refinery; 26@30 deg., $1.65 per bbl.

Philadelphia—Feb. 4, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Boston—Jan. 28, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal. light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — Feb. 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.55@$1.60.

New Plant Construction

Calif., Los Angeles—J. C. Rives, c/o F. R. Dorn, Rives-Strong Bldg., Archt., is having plans prepared for the construction of a 7 story apartment on Pico St.

Calif., San Francisco—E. N. Fritz, Jr., 1401 Masonic Ave., plans the construction of a 20 story hotel on California St. Estimated cost $1,700,000. Architect not selected.

Calif., San Francisco — Hunter-Dulin & Co., 256 Montgomery St., awarded contract for the construction of a 24 story office building at Sutter and Montgomery Sts. to Lindgren-Swinerton Inc., 225 Bush St. $3,000,000.

Calif., Santa Ana—City, E. L. Vegely, Clk., plans to purchase a 1,400 g. p. m. deep well pump and 60 hp. vertical motor.

Colo., Denver—United Theaters & Building Co., c/o F. Milton, Rivoli Theater, is having plans prepared for the construction of an office and theater building. Estimated cost $2,000,000. L. A. Desjardins, Colorado National Bank Bldg. is architect.

Conn., Greenwich—A. J. Steen, 52 Vanderbilt Ave., New York, plans the construction of an apartment at Lafayette Pl., here. Estimated cost $500,000. Architect and engineer not selected.

Conn., Hartford — G. W. Morris, 804 Farmington Ave., plans the construction of a 10 story apartment and garage building. Estimated cost $1,500,000. Architect not announced.

Fla., Coral Gables—Florida East Coast Utilities Co., is having plans prepared for the construction of a 22 story ice and cold storage plant at Greco Ave. and Le Jeune Court. Estimated cost $1,400,000. Ophuls & Hill Inc., 112 West 44th St., New York, N. Y., is architect.

Fla., Miami — Luxor Construction Co., J. J. Jacobs and J. J. Schlesinger, 219 N. E. 1st Ave., plan the construction of a 15 story hotel at 3rd St. and 20th Ave. Estimated cost $1,000,000.

Fla., Tampa—Tampa Beach Inc., J. R. Clark, Pres., has acquired a site and plans the construction of a 5 story hotel on Tampa Beach. Estimated cost $1,500,000.

Ill., Chicago—J. W. Barger & Associates, plan the construction of a 12 story hotel at Farwell and Wayne Aves. Estimated cost $1,200,000. Architect not selected.

Ill., Chicago—Cornelia Building Corp., Room 616, 310 South Michigan Ave., awarded contract for the construction of a 15 story apartment at Cornelia Ave. and Sheridan Road, to Collins, Murphy & Jackson, 310 South Michigan Ave. Estimated cost $2,400,000.

Ill., Chicago—Delaware Place Building Corp., E. L. Berman, Pres., 2310 Indiana Ave., plans the construction of a 16 story apartment at Delaware Place and Rush St. Estimated cost $500,000. J. A. Armstrong, 137 North Dearborn St., is architect.

Ill., Evanston—P. Finley, 111 West Washington St., Chicago, will receive bids about Feb. 15 for the construction of a 3 story apartment and stores building at Main St. and Elmwood Ave. here. Estimated cost $700,000. J. Loebl and N. J. Schlossman, 612 North Michigan Ave., Chicago, are architects.

La., New Orleans — E. Weil, Whitney Bldg., Archt., will receive bids until Feb. 20 for the construction of an 18 story bank and office building including ventilating equipment, 12 high speed elevators, etc. at Barome and Common Sts. for Canal Bank & Trust Co. Estimated cost $4,000,000.

Mich., Detroit—Cass Lafayette Building Co., C. J. Lingeman, Real Estate Exchange Bldg., is having plans prepared for the construction of a 26 story office building including steam heating equipment at Cass Ave. and Lafayette Blvd. Estimated cost $1,500,000. C. E. Schley, 1121 Lafayette Bldg., is architect.

Mich., Detroit—Coe Terminal Warehouse, 6620 Federal Ave., awarded contract for the construction of a 6 story warehouse including steam heating equipment on West Fort St. to Walbridge Aldinger Co., 2356 Penobscot Bldg. Estimated cost $3,000,000.

Mich., Detroit — Dept. of Public Works will receive bids until Feb. 17 for the construction of addition to asphalt plant. P. A. Fellows, City Hall, is engineer. Equipment including a dust arrestor, fan and motor, 12 in. screw conveyor, etc. will be required.

Mich., Jackson—A. Kahn, 1000 Marquette Bldg., Detroit, Archt., is receiving bids for the construction of a 9 story office building including steam heating equipment on Main St. here for Consumers Power Co., Jackson.

Minn., East Grand Forks — Ottertail Power Co., C. S. Kennedy, Gen. Mgr., Fergus Falls, will receive bids about April 1 for the installation of two 2,000 hp. capacity units to power plant, here. Estimated cost $400,000. G. W. Welch, Fergus Falls, is engineer.

Minn., St. Paul—Arcade Investment Co., H. Lowry, Pres., 600 Temple Court, Minneapolis, is having plans prepared for the construction of a 9 story hotel at Fourth and Wabasha Sts. here. Estimated cost $1,000,000. L. Bassindale, 485 Endicott Bldg., St. Paul, is architect.

Mo., St. Louis—Polar Wave Ice & Fuel Co., 3638 Olive St., awarded contract for the construction of an ice manufacturing and storage plant at Shaw Ave. and Missouri Pacific R.R. to McKelvey Construction Co., Title Guaranty Bldg. Estimated cost $400,000.

N. J., Newark—Beth Israel Hospital, will soon award contract for the construction of a 7 story hospital on Lyons Ave. Estimated cost $2,000,000. F. Grad, 1023 Broad St., is architect.

N. Y., Brooklyn—Bush Terminal Co., Foot of 43rd St., awarded contract for the construction of an office and loft building on 39th St. to Turner Construction Co., 244 Madison Ave., New York. Estimated cost $2,000,000.

N. Y., Brooklyn—Kriedel Building Corp., c/o Shampan & Shampan, 188 Montague St., Archts. and Engrs., plans the construction of an apartment at Washington Ave. and Crown St. Estimated cost $1,150,000.

N. Y., Brooklyn — One Hundred Forty Two Joralemon St. Corp., c/o M. E. Freehof, 135 East 43rd St., Archt., awarded contract for the construction of a 14 story office building to Herzig & Solomon, 415 Lexington Ave., New York City. Estimated cost $800,000.

N. Y., Brooklyn—Rapsil Construction Co., 1802 Cortelyou Road, plans the construction of a 6 story hotel at Bedford and Church Aves. Estimated cost $1,200,000. Recca & Ungerfelder, 186 Remsen St., are architects and engineers. Work will be done by separate contracts under the owner's supervision.

N. Y., Buffalo — Carr & Andrus, c/o Haugaard & Burnham, 185 Madison Ave., New York, Archts., is having plans prepared for the construction of an apartment on Lenwood Ave., here. Estimated cost $1,000,000.

N. Y., Buffalo—Federal Ice & Coal Co., 761 Kensington Ave., plans the construction of an ice manufacturing plant. Estimated cost $50,000. Refrigeration machinery will be required.

N. Y., Larchmont—F. Alexe, c/o Walker & Gillette, 128 East 37th St., New York, Archts., is having plans prepared for the construction of a 3 and 4 story, 5 unit apartment at 129 Boston Post Road, here. Estimated cost $800,000.

N. Y., New York—Jador Realty Co., Inc., c/o G. F. Pelham, 200 West 72nd St., Archt. and Engr., is having plans prepared for the construction of a 13 story hotel at 242 West 76th St. Estimated cost $750,000.

N. Y., New York—C. D. King, 95 Liberty St., is in the market for a small blower, positive blast with motor attached.

N. Y., New York—Madison Avenue & Thirty Fourth Street Corp., c/o H. I. Oser, 1440 Broadway, Archt. and Engr., is having plans prepared for the construction of a 23 story office building on Madison Ave. Estimated cost $1,000,000.

N. Y., New York—S. Paterno, c/o Cadela, 200 West 72nd St., Archt. and Engr., is having plans prepared for the construction of a 15 story hotel at 1021 6th Ave. Estimated cost $900,000.

N. Y., New York—Standard Arcade Building Corp., 50 Broadway, is having plans prepared for the construction of a 35 story office building at 44 Broadway. H. C. Severance, 36 West 44th St., is architect and engineer.

O., Cleveland — Cleveland Electric Illuminating Co., Illuminating Bldg., will soon award contract for the construction of a switch house, control house, oil storage building, etc. on Clinton Ave. Estimated cost $175,000. E. J. Cook, Illuminating Bldg., is architect and engineer.

O., Cleveland — Pallar Bros., 4531 Hough Ave., is in the market for a 3 to 5 ton refrigerating machine (used).

O., Columbus—Bd. of Trustees of Ohio State University, C. E. Steeb, Secy., will receive bids until Feb. 22 for a horizontal surface condenser for 1,000 kw. steam turbine unit.

Pa., Braddock—Day & Zimmerman, 1600 Walnut St., Philadelphia, Engrs., will build a power plant here, for United Electric Light Co., here. Estimated cost $200,000.

Pa., Philadelphia — Fidelity Mutual Life Insurance Co., 112 North Broad St., awarded contract for the construction of a 3 story office building at Parkway and Fairmount St., to Turner Construction Co., 1713 Sansom St. Estimated cost $1,500,000.

Pa., Pittsburgh—Allegheny General Hospital, Stockton Ave., plans the construction of a hospital on North Ave. Estimated cost $5,000,000. York & Sawyer, 100 East 42nd St., New York, N. Y., are architects.

Tex., Asherton — Texas Central Power Co., S. M. Udden, Mgr., Frost Bldg., San Antonio, is having preliminary plans prepared for the construction of a water works system, electrically operated, here. Estimated cost $35,000.

Tex., Dallas — General Building Corp., c/o M. Matson, 816 Thomas Bldg., is having plans prepared for the construction of a 22 story office building at Oak and Pacific Aves. Estimated cost $1,500,000. A. F. Korn, 816 Thomas Bldg. is architect.

Tex., Donna — Hidalgo County Water Improvement, plans the installation of electric motors to replace oil engines in irrigation pumping plants in Donna District. Estimated cost $580,000. Private plans.

Tex., Marshall — East Texas Public Service Co., subsidiary of the American Public Service Co., 72 West Adams St., Chicago, Ill., is having plans prepared for the construction of a 30 ton ice plant including ice-making equipment, ice tank, 30 ton raw water plant, electrical equipment, etc., here. Total estimated cost $97,500. Company engineers in charge.

Tex., Marshall—Texas Public Service Co., K. Lee, Mgr., awarded contract for the construction of an ice plant to J. M. Pressler. Estimated cost $100,000.

Tex., Sanderson—Continental Gas, Light & Power Co., Ft. Worth, has acquired the Sanderson Ice, Water & Light Co.'s plant and will have surveys made for improvements and extensions including machinery, etc., here. Private plans.

Wis., Milwaukee—Meyer Ice Co., 885 30th St., is receiving bids for the construction of an ice manufacturing plant. Estimated cost $40,000. Private plans. Ice machinery will be required.

Wis., North Fond du Lac (Fond du Lac P. O.)—Village voted $13,000 bonds for the purchase of 2 sewage pumps. J. Donohue Engineering Co., 608 North 8th St., Sheboygan, is engineer.

Wis., West De Pere—Bowman Dairy Co., 140 West Ontario St., Chicago, Ill., plans the construction of a cooling plant, here. Estimated cost $40,000. Architect not selected. Refrigeration machinery will be required.

Ont., Ottawa—Wiggins Hotel Co., is having plans prepared for the construction of a 10 story hotel on Albert St. Estimated cost $1,000,000. W. C. Beathie, 66 Craig St. is architect.